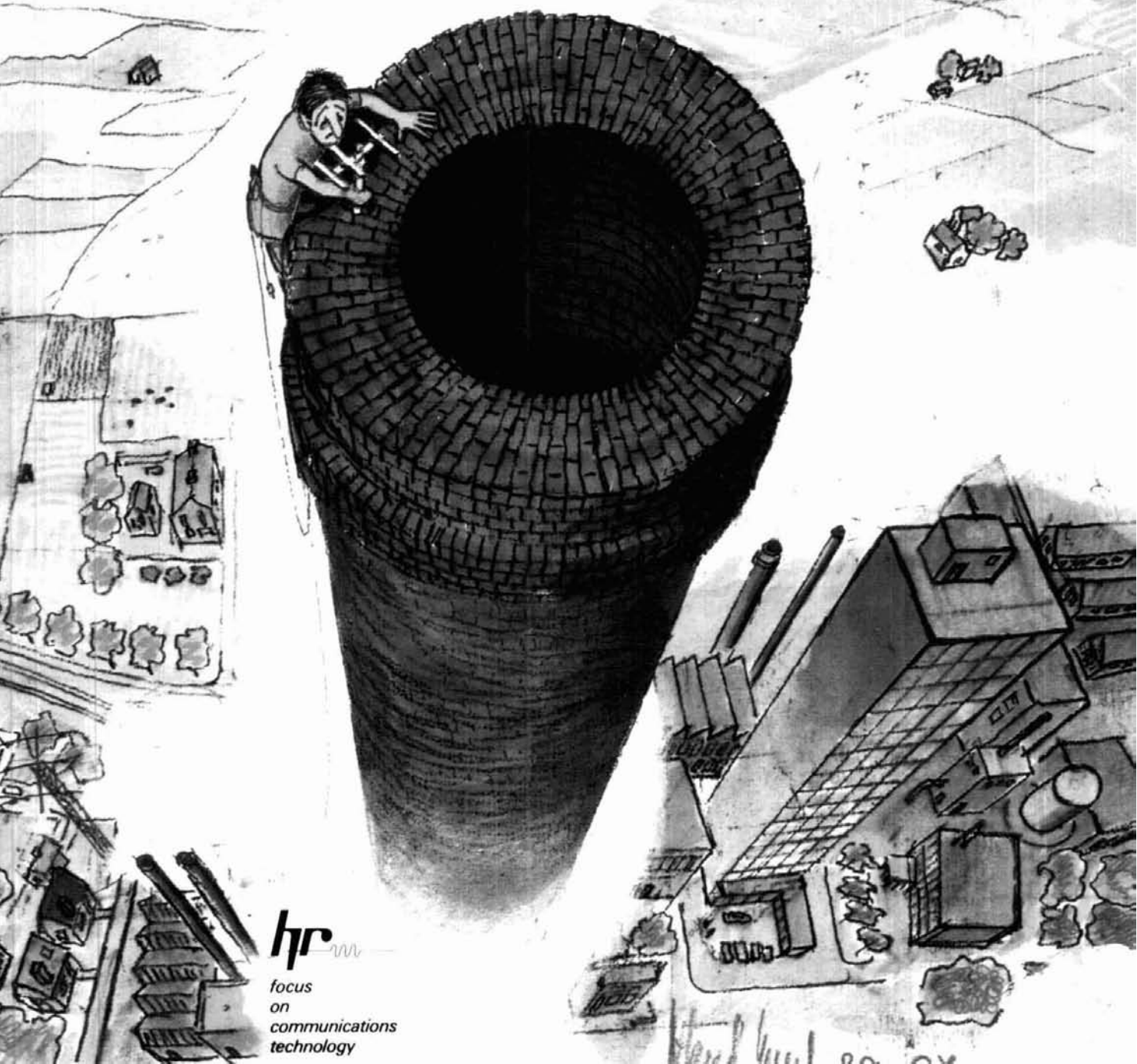


JULY 1987 / \$2.50

annual VHF/UHF issue

ham radio

magazine



hr

focus
on
communications
technology

NEW

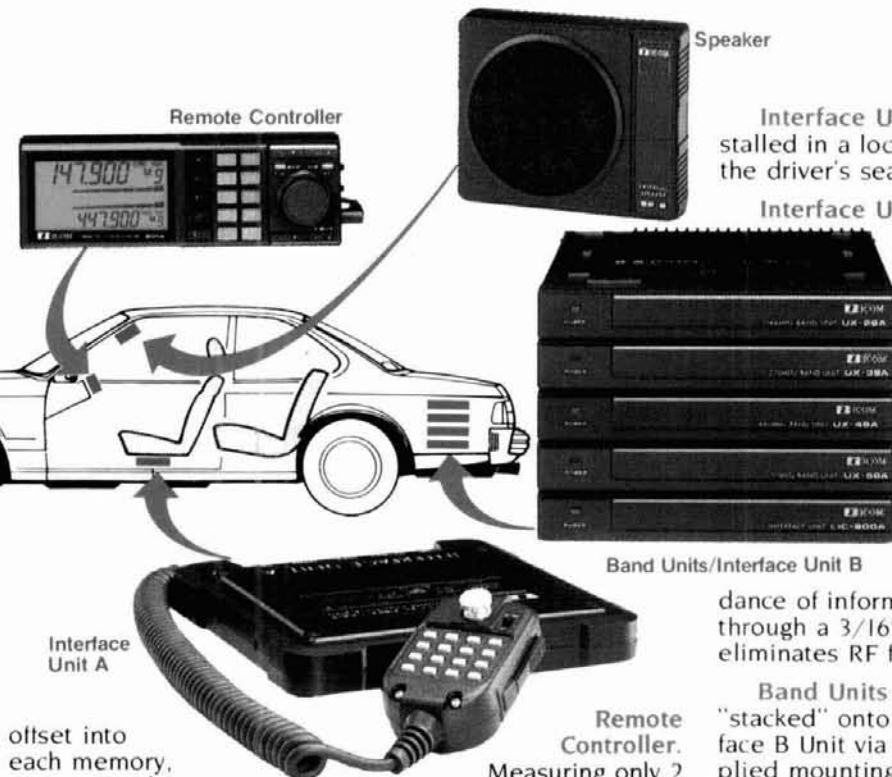
ICOM IC-900

Six Bands in One Mobile!

ICOM IC-900 FIBER OPTIC FM MOBILE

ICOM introduces the revolutionary IC-900 multi-band FM mobile transceiver. ICOM, first in utilizing fiber optic technology in amateur radio, enables you to create your own mobile communications system. Six band combinations... 10M FM, 6M, 2M, 220MHz, 440MHz, and 1.2GHz. It's the most advanced, versatile, compact, and easy-to-use mobile available.

Features Galore. The IC-900 is an operator's dream... Listen on two bands simultaneously or transmit on one band and receive on a different band when using a second speaker (**true full duplex crossband operation**), 10 memories per band, independent PL tones and



offset into each memory, memory and programmable band scan, and all subaudible tones in actual Hz readout.

The IC-900 includes an ultra compact remote controller, an Interface A unit, Interface B unit, SP-8 speaker, HM-14 up/down DTMF mic, **fiber optic** and controller cables.

Measuring only 2 inches high by 5.7 inches wide by 1 inch deep, the remote controller can be installed on your car's dash or sun visor with the supplied velcro. And, if you want, take the controller with you when you leave your car. The controller features a super large, highly visible LCD.

Speaker

Interface Unit A is installed in a location near the driver's seat.

Interface Unit B controls the six band units and can be installed in your car's trunk. A **fiber optic** cable runs from Interface A to Interface B, which transports an abundance of information through a 3/16" cable and eliminates RF feedback.

Band Units are "stacked" onto the Interface B Unit via the supplied mounting bracket. Optional band units available are:

Band Unit	Power Output	Frequency
UX-19A	10W/1W	28-30MHz
UX-29A	25W/5W	138-174MHz Rx; 140.1-150MHz Tx
UX-29H	45W/5W	138-174MHz Rx; 140.1-150MHz Tx
UX-39A	25W/5W	216-236MHz Rx; 220-225MHz Tx
UX-49A	25W/5W	440-450MHz
UX-59A	10W/1W	50-54MHz
UX-129A	10W/1W	1240-1300MHz

✓ 150



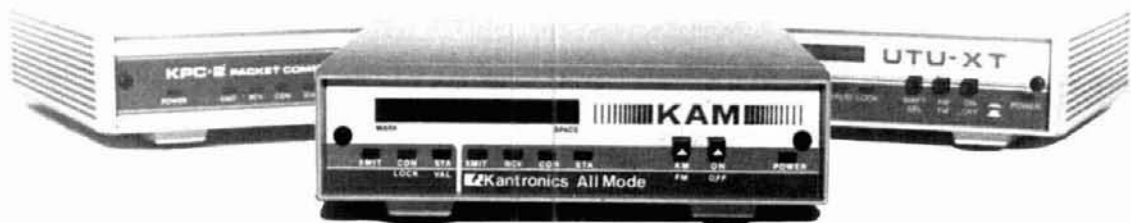
ICOM
First in Communications

ICOM America, Inc., 2380-116th Ave. N.E., Bellevue, WA 98004 Customer Service Dept.
3150 Premier Drive, Suite 126, Irving, TX 75063 / 1777 Phoenix Parkway, Suite 201, Atlanta, GA 30329

ICOM CANADA, A Division of ICOM America, Inc., 3071 - #5 Road, Unit 9, Richmond, B.C. V6X 2T1

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 90

Get It *All* Together With K A M



Kantronics All Mode

KAM gives you CW, RTTY, ASCII, AMTOR, HF and VHF PACKET all together in one unit.

We combined the features of our UTU-XT and KPC-2 to give you the true all mode unit you've been asking for, the Kantronics All Mode (KAM™).

KAM features bargraph tuning and user programmable MARK and SPACE tones for RTTY and HF packet, as well as limiter/limiterless operation on HF for weak signal operation.

KAM's CW demodulator is also programmable for both center frequency and bandwidth.

KAM's RS-232/TTL terminal interfacing provides universal compatibility to all computers, including Commodores and PC compatibles.

If you're looking for increased sensitivity and the greatest amount of flexibility in an all mode unit, look to Kantronics. We've got it all together in the Kantronics All Mode.

Suggested Retail \$319.00

KAM's FEATURES

- Transmit and receive CW 6-99, RTTY/ASCII 45-300 baud, ARQ, FEC, SELFEC, Listen ARQ, VHF and HF Packet.
- HF and VHF radio ports.
- Command driven by your computer with over 100 software commands.
- User programmable baud rates for RTTY/ASCII—selectable in one-baud increments.
- User programmable MARK and SPACE tones on HF, you choose the tones.
- Selective RTTY Autostart operation.
- Separate CW demodulator filter with programmable center frequency and bandwidth.
- Separate CW keying relay for positive or negative keying.
- 12-pole programmable switched capacitance input filtering.
- Quartz synthesized AFSK or direct FSK operation.
- RS-232 or TTL level operation by jumper selection.
- 32K RAM, 256K EPROM, EEPROM for parameter storage.
- Compatible with any computer having an asynchronous serial I/O port.
- FCC Part 15 compliant.

NEW PROGRAM

**EXTRA
SPECIAL
FEATURES**

★ Simultaneous HF and VHF Packet connects & digipeating.

★ HF/VHF Gateway operation.

Kantronics

RF Data Communications Specialists

1202 E. 23 Street Lawrence, Kansas 66046 (913) 842-7745

KENWOOD

HF to Microwaves!

TS-670

40, 15, 10, and
6-meter all mode
"Quad Bander"

- Keyboard selection of frequency, as well as "traditional" VFO
- 80 memory channels store frequency, band, mode data
- All-mode squelch, noise blanker, RF attenuator
- Optional general coverage unit, voice synthesizer, FM unit, IF filters
- QRP 10 W operation



TR-50

1.2 GHz FM transceiver

**The perfect portable
for microwave
mountain-topping!**

- 1 watt output
- LCD frequency readout with S & RF power meter
- 5 memory channels

- Odd split on memory channel 5
- Includes: Battery set, charger, external power cable, 16-key DTMF hand microphone, sleeve antenna with adjustable mount, shoulder strap.



TM-221A/321A/421A

The compact FM mobile transceivers

- **TM-221A:** 2 m, 45 W, with expanded receiver coverage (138-174 MHz).
- **TM-321A:** 220 MHz, 25 W.
- **TM-421A:** 70 cm, 35 W. The first compact 35 watt 70 cm transceiver!
- Built-in front panel-selectable CTCSS encoder. Decode optional.

- Famous high performance Kenwood GaAs FET front end.
- 14 full-function memory channels, 2 channels for odd split operation.
- 16-key DTMF mic., mic. hook, mounting bracket, and DC cable included.
- Remote control telephone-style handset option (model RC-10).



TM-221A 2 m version shown

*A complete line of accessories is available for these transceivers.
Specifications and prices subject to change without notice or obligation.
Complete service manuals are available for all Kenwood transceivers and most accessories.*

KENWOOD

KENWOOD U.S.A. CORPORATION
2201E. Dominguez St., Long Beach, CA 90810
P.O. Box 22745, Long Beach, CA 90801-5745

ham radio

magazine

JULY 1987

volume 20, number 7

T. H. Tenney, Jr., W1NLB
publisher

Rich Rosen, K2RR
editor-in-chief
and associate publisher

Dorothy Rosa, KA1LBO
managing editor

Tom McMullen, W1SL
Joseph J. Schroeder, W9JUV
Alfred Wilson, W6NIF
associate editors
Susan Shorrock
editorial production

editorial review board

Peter Bertini, K1ZJH
Forrest Gehrke, K2BT
Michael Gruchalla, P. E.
Bob Lewis, W2EBS
Mason Logan, K4MT
Vern Riportella, WA2LQQ
Ed Wetherhold, W3NQN

publishing staff

J. Craig Clark, Jr., N1ACH
assistant publisher

Rally Dennis, KA1JWF
director of advertising sales

Dorothy Sargent, KA1ZK
advertising production manager

Susan Shorrock
circulation manager

Therese Bourgault
circulation

Hans Evers, PA@CX
cover

ham radio magazine is published monthly by
Communications Technology, Inc.
Greenville, New Hampshire 03048-0498
Telephone: 603-878-1441

subscription rates

United States:
one year, \$22.95; two years, \$38.95; three years, \$49.95
Canada and other countries (via surface mail):
one year, \$31.00; two years, \$55.00; three years, \$74.00
Europe, Japan, Africa (via Air Forwarding Service): one year, \$37.00
All subscription orders payable in U.S. funds, via international
postal money order or check drawn on U.S. bank

international subscription agents: page 89

Microfilm copies are available from
University Microfilms, International
Ann Arbor, Michigan 48106
Order publication number 3076

Cassette tapes of selected articles from ham radio
are available to the blind and physically handicapped
from Recorded Periodicals,
919 Walnut Street, Philadelphia, Pennsylvania 19107

Copyright 1987 by Communications Technology, Inc.
Title registered at U.S. Patent Office

Second-class postage paid
at Greenville, New Hampshire 03048-0498
and at additional mailing offices
ISSN 0148-5969

Send change of address to ham radio
Greenville, New Hampshire 03048-0498



contents

**8 high-performance Yagis
for 432 MHz**

Steve Powlisken, K1FO

**33 build a 1-1000 MHz amplifier
using MAR-4 MMICs**

Cliff Klinert, WB6BIH

**38 VHF/UHF world: operating
a VHF/UHF/microwave station**

Joe Reisert, W1JR

Note: MININEC, as described in the May, 1987, "VHF/UHF
World," is not available from NOSC — see page 49.

**53 improved gain distribution
for the Yaesu FT-726R**

Peter J. Bertini, K1ZJH

57 ham radio techniques

Bill Orr, W6SAI

**62 practically speaking:
battery problems — part 1**

Joe Carr, K4IPV

67 the weekender: an improved RDF

Joe Moell, K0OV

74 locator field list

Folke Rosvall, SM5AGM

92 Elmer's notebook

Tom McMullen, W1SL

**98 advertisers index
and reader service**

6 comments

78 DX forecaster

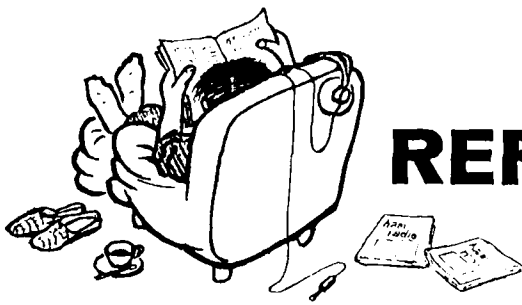
90 flea market

88 ham mart

81 new products

4 reflections

**6,49,91 short
circuits**



REFLECTIONS

13 cm: onwards and upwards

Some view the spectrum above 1 GHz as a vast, sterile desert devoid of life, difficult to get to, and of questionable worth once attained. But, just as in the desert (which, of course, teems with life), what you see isn't necessarily what you get.

To the uninitiated, fear of the unexplored prompts questions such as "What the heck's it good for?", "Who can I talk to?", and "How do I get there in the first place?" These aren't bad questions, but they've all been asked before — about 5 meters, 2 meters, 70 cm, and most recently, 23 cm. Yet saturation of 2 meters is a fait accompli in many areas; 70 cm isn't far behind, and 23 cm is being staked out by many repeater operators looking for turf.

One senses repetition of a familiar pattern. Any "new" band is first occupied by the desert rats who build their own transmit and receive converters, antennas, and preamps. A few of them begin selling their special boxes to friends; soon, the more entrepreneurial types among them begin marketing the product on a limited scale. Later, when the commercial possibilities are obvious, the large, established manufacturers jump in. With their sizeable R&D and engineering resources, they quickly develop commercially attractive boxes, with legible control labels replacing the chicken scratches on bare aluminum typical of the earlier models.

To potential users of the new band, operation now becomes much more feasible. No new skills need be acquired. Often, simply knowing how to use a credit card is sufficient: just unpack the box, hook up the unit, and you're *there*.

By my reckoning, critical momentum for 2 meters was achieved in 1971 or 1972; for 70 cm, in 1978 or 1979; and for 23 cm, in 1984 or 1985. By the same measure, I figure "critical mass" for 13 cm (2.4 GHz) will occur sometime about 1989 or 1990. All indicators suggest that a big push into this band is imminent. Entrepreneurs now offer 13-cm transverters, loop yagis, and preamps. Moreover, military and commercial applications of S-band systems, equipment, modules, and components have fueled development of low-cost microwave devices (including integrated circuits) to the point where getting on 13 cm is much less expensive than it was just a few years ago. Obviously, since cost is a predominant design driver in the Amateur market, this development is of paramount interest to would-be manufacturers of 13-cm Amateur equipment.

The demands for spectrum and services in the lower Amateur bands (70 cm and below) exert continuous pressure to move to less congested territory. Digital communications, particularly packet radio networking and digitized voice and video, are notable forces propelling users up to 23 cm and soon, on to 13 cm.

In the context of 13 cm, the answer to the familiar question, "Who can I talk to up there?", may differ from the answers that were appropriate when the question was raised in regard to 70 cm and 2 meters. This is because important breakthroughs are now occurring in the development of Amateur satellites (OSCARs) — in the frequencies to be used, the modes to be employed, and the platforms (i.e., satellites) used to carry equipment into space. More significantly, however, these breakthroughs may finally allow more Amateurs than ever before to participate in satellite communications.

The first steps will be modest. In 1988, AMSAT will launch Phase 3C, with four transponders aboard; one of these will be a small 70-cm uplink, 13-cm downlink fm repeater. This easily acquired downlink may carry fm voice bulletins suitable for linking through gateway repeaters.

Just a few years from now, in 1991, AMSAT's Phase 4 geosynchronous satellite will provide several classes of service at 13 cm, including voice and data as well as gateway linking, so that hams using HTs in one city will be able to interconnect through a local gateway with gateways and HTs in another. So the question, "Who can I talk to on 13 cm?" will soon be answered by "Who would you like to talk to?"

Progress in these areas will bring new problems, however. As advances in technology drive down the cost of Amateur UHF and SHF equipment, commercial interests will find those portions of the spectrum increasingly appealing. Even now, they're eyeing the seemingly infertile UHF territory for suitable enclaves. The Amateur allocation at 13 cm is looking more attractive than ever, and has quickly become interesting real estate to those who would sell services based on occupancy of S-band spectrum.

This means that Amateurs can't afford to delay making productive use of the 13-cm band. In short, we need to get busy and make that 13-cm desert bloom — with useful public service and emergency communications services, packet radio networks, and educationally significant communications as well as our traditional goodwill-building communications. Let's keep our hold on that band by planning for meaningful occupancy and by supporting those concrete efforts towards widespread utilization of 13 cm — such as Phase 3C and Phase 4 — already underway.

Vern "Rip" Riportella, WA2LQQ
President, AMSAT

KENWOOD

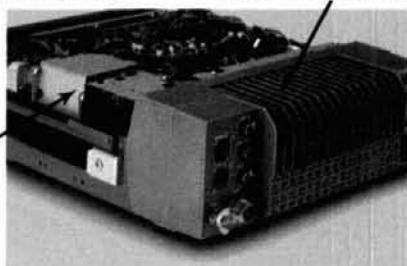
All New
Compact HF!

“DX-citing!”

TS-440S Compact high performance HF transceiver with general coverage receiver

Kenwood's advanced digital know-how brings Amateurs world-wide "big-rig" performance in a compact package. We call it "Digital DX-citement"—that special feeling you get every time you turn the power on!

- **Covers All Amateur bands**
General coverage receiver tunes from 100 kHz – 30 MHz. Easily modified for HF MARS operation.
- **Direct keyboard entry of frequency**
- **All modes built-in**
USB, LSB, CW, AM, FM, and AFSK. Mode selection is verified in Morse Code.
- **Built-in automatic antenna tuner (optional)**
Covers 80-10 meters.
- **VS-1 voice synthesizer (optional)**



- **Superior receiver dynamic range**
Kenwood DynaMix™ high sensitivity direct mixing system ensures true 102 dB receiver dynamic range. (500Hz bandwidth on 20m)
- **100% duty cycle transmitter**
Super efficient cooling permits continuous key-down for periods exceeding one hour. RF input power is rated at 200 W PEP on SSB, 200 W DC on CW, AFSK, FM, and 110 W DC AM. (The PS-50 power supply is needed for continuous duty.)



- **Adjustable dial torque**
- **100 memory channels**
Frequency and mode may be stored in 10 groups of 10 channels each. Split frequencies may be stored in 10 channels for repeater operation.
- **TU-8 CTCSS unit (optional)**
Subtone is memorized when TU-8 is installed.
- **Superb interference reduction**
IF shift, tuneable notch filter, noise blanker, all-mode squelch, RF attenuator, RIT/XIT, and optional filters fight QRM.
- **MC-43S UP/DOWN mic. included**
- **Computer interface port**
- **5 IF filter functions**
- **Dual SSB IF filtering**
A built-in SSB filter is standard. When an optional SSB filter (YK-88S or YK-88SN) is installed, **dual** filtering is provided.
- **VOX, full or semi break-in CW**
- **AMTOR compatible**



Optional accessories:

- AT-440 internal auto. antenna tuner (80 m – 10 m)
- AT-250 external auto. tuner (160 m – 10 m)
- AT-130 compact mobile antenna tuner (160 m – 10 m)
- IF-232C/IC-10 level translator and modem IC kit
- PS-50 heavy duty power supply
- PS-430/PS-30 DC power supply
- SP-430 external speaker
- MB-430 mobile mounting bracket
- YK-88C/88CN 500 Hz/270 Hz CW filters
- YK-88S/88SN 2.4 kHz/1.8 kHz SSB filters
- MC-60A/80/85 desk microphones
- MC-55 (8P) mobile microphone
- HS-5/6/7 headphones
- SP-40/50B mobile speakers
- MA-5/VP-1 HF 5 band mobile helical antenna and bumper mount
- TL-922A 2 kw PEP linear amplifier
- SM-220 station monitor
- VS-1 voice synthesizer
- SW-100A/200A/2000 SWR/power meters
- TU-8 CTCSS tone unit
- PG-2S extra DC cable.

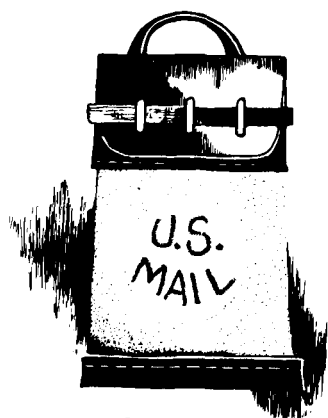
Kenwood takes you from HF to OSCAR!



Complete service manuals are available for all Kenwood transceivers and most accessories. Specifications and prices are subject to change without notice or obligation.

KENWOOD

KENWOOD U.S.A. CORPORATION
2201 E. Dominguez St., Long Beach, CA 90810
P.O. Box 22745, Long Beach, CA 90801-5745



comments

DARC awards

Dear HR:

Many DXers in the United States and Canada either do not know that there is such a thing as a "Worked All Europe" (WAE) or other DARC awards, or are afraid to send their cards to Europe because of the cost and the possibility of loss.

I am now the United States/Canadian checkpoint for all DARC awards. All information, including a list of countries, plus record sheets and application forms, can be obtained from me for a No. 10 SASE plus \$1.00.

**Ralph M. Hirsch, K1RH,
Woodbridge, Connecticut 06525**

for the birds

Dear HR:

I was intrigued with Bernard Kirschner's request for ideas on how to discourage live owls from attacking a plastic owl installed as a bird-detering antenna ornament (Comments, May, 1987, page 6).

As a salesman, I call regularly on a company that had a similar problem. A small park in the company's front yard was beautiful until the birds came, complete with droppings. Walking through the park turned into an inspiration to take up jogging — make that *sprinting*.

Fortunately, this is a high technology company full of bright scientists and engineers ready to tackle any problem. First they tried a plastic owl, deployed in a variety of locations in the park with little noticeable effect. Then they tried directing ultrasonic pulses at the park — no effect. Finally, they

hung a life-sized plastic eagle from the middle of a drooping wire (you might try nylon rope in order to avoid interfering with antenna patterns) suspended about 20 feet above the park. As the eagle moves up and down in the wind, it spreads its wings, discouraging smaller birds.

Nature's pecking order puts the eagle at the top of the birds' list of daytime predators. Being nocturnal, owls prey mostly on rodents; perhaps that's why few smaller birds have learned to fear them?

I hope this idea helps.

**John D. Seney, KB1HE,
Manchester, New Hampshire
03013**

hams of the future

Dear HR:

I want to thank everyone who contributed to my receiving AEA's 1986 Ambassador award, which I accept on behalf of all of us who have been sharing our hobby with "outsiders" for years. AEA's award thrusts the Redwood Youth Foundation's program into high visibility.

We now have academically accredited ham radio classes in three secondary schools in Santa Cruz, with several more planned, and many other schools pleading for us to initiate the program for them. All this has been made possible by Ben Deovlet, WB6FDU — our chief donor, tech advisor, and cheerleader for the past five years — as well as many other generous hams who contributed gifts of time, effort, and equipment.

Thanks to these many donors and volunteers, the Redwood Youth Foundation has sponsored several International Youth TeleCongresses and conducted multinational Teleconferences via computer. . . all for less than the cost of one field trip to the zoo per school!

All this attracts young people of all colors, creeds, and ideologies. We've never seen so many young people so totally electrified, as they network with peers everywhere, learning how to communicate and cooperate.

Young networkers need *your* exper-

tise! How about volunteering to be the school program facilitator in *your* town?

Jack Anderson said, "Every generation, if it is to fulfill itself, must have a dream to inspire it and an adventure to ennoble it." I invite all of us to help inspire and ennoble this generation of teens. History is waiting for us to take our kids with us as we explore our new, almost infinitely expandable electronic "space."

**Mary Duffield, WA6KFA
Santa Cruz, California 95062**

short circuit

compact 20-meter travelradio

In K1BQT's article, "Compact 20-meter CW Travelradio" (June, 1987, page 8), part numbers were omitted for the following:

CW filter IC	1458 dual op amp
Q8	2N3906
Q9	MPS2222
Q10	BS-170
Q11	MRF479

With the exception of MRF479, all of the above parts are available from Radio Shack; the MRF479 is available from RF Parts, 1320 Grand Avenue, San Marcos, California 92069.

Figure 7B (main board layout, page 19) should have indicated the positioning of the ICs; the key on U4 goes toward the 10 μ F electrolytic, and the key on U2 goes toward T2 (IF can). In fig. 10B (CW audio filter), the key on the 1458 op amp goes away from the 10 μ F electrolytic.

The 914 diode shown located next to the 20-k trim pot (S-meter zero control) in fig. 7B should be designated as a 9.0-volt, 400-milliwatt zener diode (Z1 in parts list).

SHORT CIRCUIT HOTLINE

Building a current ham radio project? Call the Short Circuit Hotline any time between 9 AM and Noon, or 1 to 3 PM — Eastern time — *before* you begin construction. We'll let you know of any changes or corrections that should be made to the article describing your project.
(See "Publisher's Log," April, 1984, page 6, for details.)

603-878-1441

KENWOOD

NEW!
45/35 Watt
Dual Bander

First Again!

TW-4100A

2 m/70 cm FM Dual Bander

A Kenwood original just got better! Kenwood was the first to develop a 2 m/70 cm mobile radio in a single, compact package. Since then, other companies have imitated the concept, but still have not done it the "Kenwood way." The all-new TW-4100A is more compact, more powerful, and packed with more features than ever before! With many new features and accessories, and backed by Kenwood's experience, the all-new Kenwood Dual Bander is light years ahead of the rest!

- Selectable full duplex cross band ("telephone style") operation. Remote base or cross band repeater function possible (a control operator is needed for remote or repeater operation).
- 45 watts on 2 m. 35 watts on 70 cm. 5 watts (adjustable) low.
- Frequency coverage: 142-149 MHz (allows operation on certain MARS and CAP frequencies) and 440-449.995 MHz.

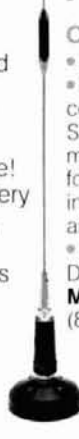


- New compact size! Only 5.9" W x 1.97" H x 7.87" D and weighs less than 4 pounds!
- Proven high performance Kenwood GaAs FET front end receiver.
- Easy to operate! Only 3 knobs and 8 keys on the front panel.
- Separate antenna ports for VHF and UHF. Minimizes loss and increases reliability and performance!
- 10 memory channels. Lithium battery backs up memory. Store frequency, offset, subtone. Two channels store the transmit and receive frequencies independently for odd split or cross band operation.
- Front panel-selectable CTCSS tone (when optional TU-7 is installed.)

- Non-volatile operating system. Even after memory back up cell dies, all operating features remain intact! No re-programming or "board-swapping" necessary!
- Programmable band scan and memory scan with memory channel lock-out.
- Large, illuminated LCD display and main knob. For excellent visibility in direct sunlight or darkness.
- Selectable frequency step for quick and easy QSY.
- Voice synthesizer VS-2 option.

Optional accessories:

- PS-50/PS-430 DC power supplies
- MU-1 DCL modem unit • TU-7 CTCSS encoder • VS-2 Voice synthesizer • SW-100B SWR/Power/Volt meter 140-450 MHz for mobile use • SW-200B SWR/Power meter for base station use 140-450 MHz. 0-200 W in 2 ranges • SWT-1/SWT-2 2 m and 70 cm antenna tuner • SP-40 Compact speaker
- SP-50B Mobile speaker • PG-2N Extra DC cable • PG-3B DC noise filter • MC-60A, MC-80, MC-85 Base station mics. • MC-55 (8-pin) Mobile microphone • MA-4000 Dual band mobile antenna with duplexer (shown)**
- MB-11 Extra mobile mount



- Digital Channel Link (DCL) option.

KENWOOD

KENWOOD U.S.A. CORPORATION
2201 E. Dominguez St., Long Beach, CA 90810
P.O. Box 22745, Long Beach, CA 90801-5745

*Please check FCC regulations on repeater operation

**Mag mount is not Kenwood supplied

Minor modification necessary for repeater operation

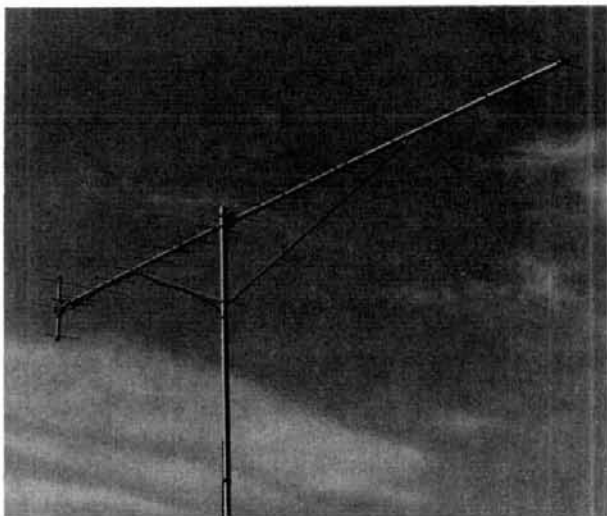
Specifications and prices subject to change without notice or obligation

Complete service manuals are available for all Kenwood transceivers and most accessories.

high-performance Yagis for 432 MHz

Practical application
of computer analysis

This article describes two long Yagis for 432 MHz. Both offer excellent gain, given their boomlengths, and exceptionally clean pattern. Details of the development and construction of these Yagis, which were designed to be easily built from a commercial antenna, are given. In addition, dimensions are presented for two higher gain Yagis which offer even better theoretical performance, but have not yet been checked by the construction of test antennas.



The Cushcraft 424B offers sound mechanical construction at a reasonable price.

few 432 MHz designs

Three years ago I was searching for a good Yagi design to use in a new 432-MHz array. The selection of commercially available antennas for 432 MHz has always been very limited because the number of stations active on 432 MHz is small enough to make the design and production of commercial antennas for this frequency a proposition of limited, if any, profitability. Consequently, manufacturers have been slow to incorporate the latest developments in Yagi design.

Fortunately, Günter Hoch, DL6WU, had developed a director spacing and length combination which offered very good gain, a relatively clean pattern, and the ability to easily lengthen or shorten the Yagi without causing the gain peak to shift appreciably.¹ In all, the DL6WU design was a significant improvement over most previous Amateur designs. Several United States Amateurs had discovered this information and successfully built 432-MHz Yagis from it.

The use of Günter's design data required a start-from-scratch approach. However, most Amateurs find building antennas from scratch is unacceptable because of the lack of convenient sources of materials and the necessity of construction equipment and machining skills. Modifying a commercial Yagi to perform as well or better than the DL6WU design allows more Amateurs to experience the benefits of a high performance 432-MHz antenna system.

improving a good design

The starting point for the development of these Yagis was the Cushcraft 424B, which offered sound mechanical construction at a reasonable price. By

By Steve Powlishe, K1FO, 816 Summer Hill Road, Madison, Connecticut 06443

working from a proven design, it was possible to reuse most of the components and hardware to make a good product even better.

better pattern, higher gain

My goal was to increase the gain, clean up the radiation pattern of the antenna, and get an acceptable wet-weather VSWR, while widening the gain bandwidth. The initial project was so successful that an extended boomlength version was also perfected.

An initial look at the 424B shows that it uses one close-spaced director of 0.135 wavelength spacing, a second director spaced at 0.368 wavelength, and the rest of the directors spaced at 0.375 wavelength. The first ten directors have a length taper. The final ten are all the same length. Long Yagis (over 5 wavelengths), which use constant director spacings, generally have radiation patterns with very high sidelobe levels and overly narrow main lobes. In addition, such director arrangements create Yagis with narrow gain bandwidths and a very sharp gain dropoff on the high frequency side of the gain peak. Design improvements are even more beneficial when the Yagi is used in an array. Reference 2 illustrates this relationship. Mutual impedance effects, which tend to lower the gain peak frequency of an array versus the individual Yagis, also magnify these shortcomings in an array.

One little-known aspect of the NBS study was that the researchers tried designs up to 7 wavelengths long. These longer Yagis were not included in the formal NBS report (*NBS Technical Note No. 488*), however — probably because of their poor performance. NBS researchers faced the limitations of constant spacing Yagis over 30 years ago; unfortunately, the NBS study wasn't extended to include variable spacing Yagis.

The development of these new Yagis began on a backyard antenna range. The first step was the addition of another close-spaced director, which improved the pattern but gave no significant gain increase. Application of directors with a constant taper gave further pattern improvements but still no meaningful gain increase. The time and effort required to build and measure the different antenna designs gave me some insight as to why Cushcraft ended their development of the 424B at the point they did: the task of optimizing the directors' lengths while simultaneously keeping the Yagi's gain peak near 432 MHz and maintaining a reasonable driven element match appeared to be overwhelming.

computer analysis helped

The WB3BGU series of articles on the computer analysis of Yagis³ ended with a description of the computer program, which *ham radio* made available to

readers for an SASE. Initially, I set up the program in FORTRAN (in which the original was written) on a computer at work; I then translated it to BASIC, which could be run on a home computer. The translation to BASIC gave me the opportunity to correct some bugs in the program and add graphics routines.

I spent the next three months analyzing every Yagi design for which I could get dimensions, paying special attention to designs with reliable pattern and gain data. Such an examination of the program was deemed necessary in order to ensure that any design created with the program would offer realistic results.

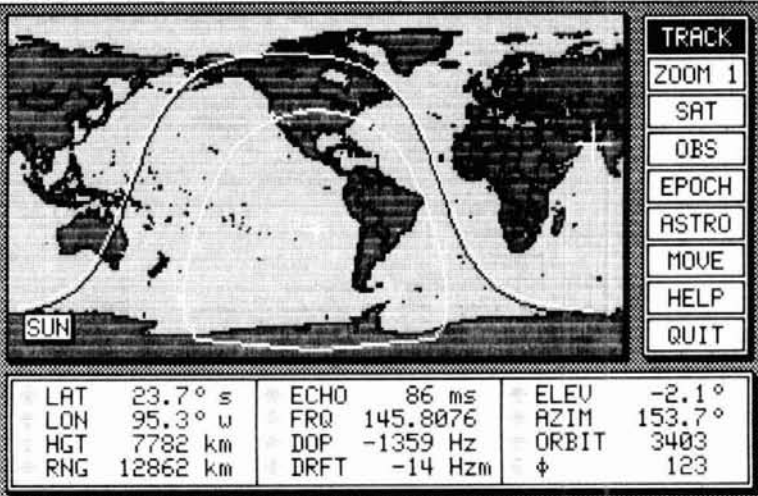
Computer analysis of various designs confirmed the desirability of both additional close-spaced directors and an element taper to improve the pattern of the Yagi. Antenna modeling indicated that continuously increasing spacing, as used by DL6WU, was *not* necessary to create a high performance Yagi. In fact, it appeared that several less complicated spacing patterns could be used as long as all element lengths were optimized for that chosen spacing. An important step in the design of the improved Yagi, it was intended to retain as many of the original 424B element spacings as possible in order to simplify construction.

There are distinct advantages of the DL6WU design approach. The foremost is the ability to add or subtract directors without having the gain peak frequency shift appreciably. A number of designs were examined for frequency shift as elements were added. It was found that the center frequency of all Yagi designs oscillates up and down as elements are added. Even the DL6WU design shows this tendency, though the effect was the least of all designs examined. The wide gain bandwidth of the DL6WU design also minimized any frequency shift effects.

The 24- and 32-element designs presented here all have similar dimensions. Note that the directors of the 24-element Yagi are shorter than the 32-element version. Both Yagis have been adjusted to have a gain peak that's very close to the same frequency (436 MHz), even though the elements lengths are different for the two Yagis. One should be forewarned that if construction of a Yagi from this design with a different number of elements is attempted, its gain peak may be several MHz away from that of the 24- or 32-element antennas.

variable element lengths and spacings

The Yagi designs presented in this article use both varying element spacings and lengths. This was consistently found to give not only the highest gain, but the cleanest patterns and widest gain bandwidths. DL6WU pointed out the theoretical reasons for this condition.⁴ Long Yagi designs which use either con-



MIRAGE/KLM

COMMUNICATIONS EQUIPMENT, INC.

P.O. BOX 1000 MORGAN HILL, CA 95037

MIRAGE TRACKING INTERFACE

"MTI" IS THE ONLY SMART INTERFACE BOX THAT WORKS WITH SILICONE SOLUTIONS™ SOFTWARE.

"MTI" OFFERS AUTOMATIC TRACKING OF ANY ORBITING BODY.

"MTI" KEEPS ANTENNAS AIMED CORRECTLY AT ALL TIMES.

"MTI" COMES WITH A ONE YEAR WARRANTY FROM MIRAGE/KLM.

"MTI" OFFERS ONE YEAR SOFTWARE SUPPORT TO REGISTERED OWNERS.

"MTI" IS AVAILABLE FROM MIRAGE/KLM ONLY. CALL FOR MORE DETAILS ...

(408) 779-7363 or outside CA,
(800) 538-2140

FEATURES INCLUDE:

- SWITCH SELECTABLE — ELEVATION FROM 0° - 90° AND 0° - 180°
- " — ELEVATION SCALING X1 OR X2
- " — NORTHERN OR SOUTHERN HEMISPHERE
- " — MANUAL OR AUTOMATIC MODE
- " — BAUD RATE (300 - 2400)
- 100 PAGE DETAILED MANUAL
- CABLE FOR KENPRO'S™ "A" SERIES CONTROLLER

MIRAGE/KLM

✓ 152

COMMUNICATIONS EQUIPMENT, INC.

P.O. BOX 1000 MORGAN HILL, CA 95037

(408) 779-7363

(800) 538-2140 (outside CA)

440-6X

ELECTRICAL:

BANDWIDTH.....	420-460 MHz
GAIN.....	8.9 dBd
VSWR.....	1.5:1
F/B.....	20 dB
BEAMWIDTH.....	60°
FEED IMP.....	50 ohm
BALUN.....	4:1 coax

MECHANICAL:

ELEMENT LENGTH.....	13½" max.
BOOM LENGTH.....	28"
TURN RADIUS.....	28"
WINDLOAD.....	.2 sq. ft.
WEIGHT.....	1 lb.
MAST.....	1½" o.d.
MOUNT.....	Rear

440-10X

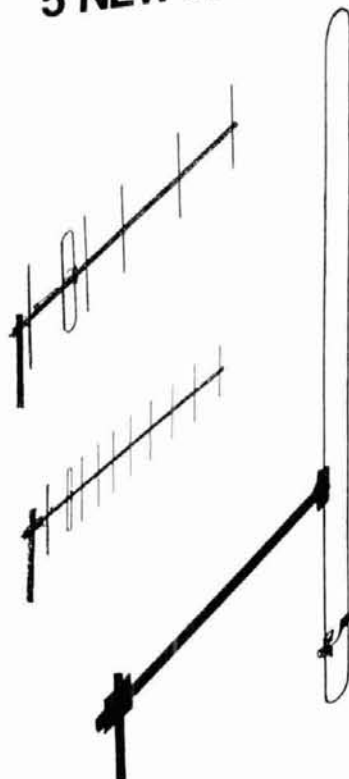
ELECTRICAL:

BANDWIDTH.....	420-460 MHz
GAIN.....	11.2 dBd
VSWR.....	1.5:1
F/B.....	20 dB
BEAMWIDTH.....	48°
FEED IMP.....	50 ohm
BALUN.....	4:1 coax

MECHANICAL:

ELEMENT LENGTH.....	13½" max.
BOOM LENGTH.....	64"
TURN RADIUS.....	64"
WINDLOAD.....	.4 sq. ft.
WEIGHT.....	1½ lbs.
MAST.....	1½" o.d.
MOUNT.....	Rear

PRESENTS 5 NEW ANTENNAS



ALL CJ ANTENNAS INCLUDE
INSULATED SUPPORT MAST

CALL YOUR DEALER TO ORDER ONE NOW!

CJ2M

ELECTRICAL:

BANDWIDTH.....	144-148 MHz
GAIN.....	1.8 dBd
VSWR.....	1.5:1
FEED IMP.....	50 ohms

NO GROUND PLANE REQUIRED

MECHANICAL:

HEIGHT.....	61"
WEIGHT.....	2½ lbs.
MAST.....	1½" o.d.

CJ220

ELECTRICAL:

BANDWIDTH.....	220-224 MHz
GAIN.....	1.8 dBd
VSWR.....	1.5:1
FEED IMP.....	50 ohms

NO GROUND PLANE REQUIRED

MECHANICAL:

HEIGHT.....	40"
WEIGHT.....	2 lbs.
MAST.....	1½" o.d.

CJ440

ELECTRICAL:

BANDWIDTH.....	420-470 MHz
GAIN.....	1.8 dBd
VSWR.....	1.5:1
FEED IMP.....	50 ohms

NO GROUND PLANE REQUIRED

MECHANICAL:

HEIGHT.....	19¼"
WEIGHT.....	1 lb.
MAST.....	1½" o.d.

stant element spacings or element lengths give poorer performance and should no longer be worthy of consideration for use by VHF/UHF weak signal operators.

The formal design of the 432-MHz super Yagis started with a selection of varying director spacings. These were chosen to fit best within the existing element holes to minimize the necessity of drilling new holes in the boom. I tried adapting the DL6WU spacing pattern to the 424B; except for the final director, spacing became 10.25 inches (260 mm) or 0.375 wavelengths, since that was the ultimate spacing of the 424B. The DL6WU design used a final spacing of 11 inches (280 mm) or 0.400 wavelengths. Electrically, this approach appeared to work very well. Mechanically, however, this was not an acceptable solution because eight or nine new holes would have to be drilled into the boom — not in keeping with the relatively simple modification I was hoping to develop.

Next, five different new spacing patterns were examined on the computer. It was apparent that a good progressive spacing pattern didn't fit easily within the existing holes. The solution was to move the position of the driven element. Once this was done, an acceptable spacing arrangement was adapted to the 424B. The extra effort in devising this new director arrangement paid off by making a new design that requires only three new element holes to be drilled in the boom.

Though not yet the ultimate answer, this extensive computer analysis (and in general, use of the computer in antenna design) helps to dispel several long-standing myths Amateurs have maintained about Yagi design. *The first myth is the notion that a design has to be optimized for either highest gain or best radiation pattern.* It was found that for designs with proper variable spacing arrangements, the best gain and best pattern solutions were convergent. While a design could be adjusted to maximize any particular aspect of the radiation pattern (lowest first sidelobes, highest f/b), the best overall pattern quality occurred concurrently with the highest forward gain solution. *The only way to further improve the pattern was to move the operation point of the Yagi lower on its frequency response curve — i.e., slightly shorten all of the directors.* I found that first sidelobe strengths were usually close to -18 dB in the E plane and -16 dB in the H plane when a Yagi with a good spacing pattern was optimized. Students of physics will recognize the significance of -18 dB because it's the expected strength of the first sidelobes from a fully illuminated circular aperture.

Another common myth holds that when a Yagi is tuned for maximum gain, its bandwidth will be very narrow. This condition was found to be true for constant spacing and constant length designs, but it was also true for those constant designs *even when they were not gain optimized.* For designs with variable

spacings and lengths, the gain bandwidth of such designs was remarkably wide. Even more significant was the fact that the gain bandwidth was best when the elements were optimized for maximum forward gain. As an indication of this wide gain bandwidth the 24-element modified Yagi has a -1.0 dB gain bandwidth of 25 MHz! (Gain bandwidth should not be confused with VSWR-bandwidth. VSWR bandwidth is merely an indication of feed impedance versus frequency and is not normally an indication of forward gain.)

single reflector used over trigon

At this point I decided to drop the tri-reflector arrangement in favor of a single reflector. There have been some exaggerated claims made for various multiple reflector arrangements. Previous experimental work indicated that any of the various multiple reflector arrangements gave about 0.2 dB additional gain over a single reflector, once they were optimized for the individual Yagi design to which they were added. *Subsequent computer analysis has indicated that the amount of additional gain obtainable in these multiple reflector arrangements decreases in direct proportion to how well the directors are optimized.* That is to say, an antenna that doesn't have its directors fully optimized for maximum forward gain could very well see 0.5 dB additional gain with the addition of a tri-reflector or screen reflector. Conversely, a Yagi with its directors optimized for maximum gain may be fortunate to see a 0.1-dB gain improvement from such a multiple reflector arrangement.

There also seems to be a common misconception that multiple reflector arrangements improve the f/b ratio. Except for screen or grid reflectors such as those used by DL9KR, this has not been observed to be the case.⁵ Dual or tri-reflectors show some tendency to increase the bandwidth over which a particular f/b will be maintained, but don't show any consistent tendency to always increase the f/b. Many of these multiple reflector arrangements can be tuned to decrease the strength of the rear lobe right at 180 degrees. Since the overall gain of the Yagi doesn't significantly increase with these multiple reflector arrangements, the strength of other minor lobes increases. It should also be noted that the actual f/b at the 180-degree point of the pattern is not a good indicator of the performance of a Yagi. Many Yagis, including the stock 424B and F9FT-21 element Yagi have nulls at the 180-degree point which give an artificial sense of a high f/b. In order for a Yagi to have an excellent G/T (Gain-to-Noise Temperature ratio), it must have all lobes in the rear hemisphere of the Yagi, *in all planes*, down a significant amount (over 25 dB). Lobes on either side of 180 degrees are actually conical in shape when the antenna pattern is viewed in three dimensions. There-

fore, they intercept a large amount of radiated energy and can be a troublesome source of noise reception. The modified Yagis have measured f/b ratios of close to 25 dB. In addition, the lobe at 180 degrees is strongest in the rear hemisphere of the pattern and almost all other rear lobes are down 30 dB or more.

If a high or broadband f/b ratio is desired, a non-tuned grid or screen reflector arrangement will be most effective. If one is concerned mainly with forward gain and pattern at a particular frequency, none of the multiple reflector arrangements is as effective in terms of windload versus additional gain when compared to simply lengthening the boom and adding more directors.

The quad-type feed and reflector were also examined. Many of the performance claims for the quad feed were not substantiated by computer analysis. It was found that on short Yagis (under 1.5 wavelengths) the quad feed added a couple of tenths of a dB in additional gain versus a dipole feed. However, in considering the quad feed and reflector, one must also account for the additional windload and weight that it adds. As in the tri-reflector, the gain-versus-windload war would be won by adding directors to a dipole-fed Yagi. The longer the Yagi was, the less effect the quad feed had. In fact, at 5 wavelengths (boom), no measurable gain advantage was noticed by using a quad feed and reflector.

One area in which a quad feed can offer an advantage is in VSWR bandwidth — i.e., the VSWR could be held under a certain value over a wider frequency range. If a quad feed is used on a long Yagi, I highly recommend using a balun. Pattern measurements on quagi-type antennas have usually shown significant pattern imbalances. Another myth about quagis has been that they have better patterns; yet an examination of existing quagi designs, both on the computer and on my antenna range, indicated that their patterns are substantially poorer than any modern Yagi such as the DL6WU design or the designs presented here. Attempts were made on the computer to adapt the quad feed to more modern director strings. The results were not very successful. The quad feed seemed to require a very wide first director spacing in order to get acceptable forward gain. This wide first director spacing then caused pattern deterioration. The net result was to drop further efforts on quagi-type antennas.

design knowledge reduces computer time

The computer hardware available to me over a year ago required about 2-1/2 minutes to calculate the gain and pattern of the 24-element Yagi and close to 4 minutes to calculate the 32-element version. Considering that every time an element length was changed,

every other element had to be checked to see if its length should also be changed, the number of calculations required to optimize each of the elements might require sitting at the computer for half a year. To free me from that chore, I designed an algorithm to optimize the element lengths automatically. This algorithm could also be utilized to optimize element spacings. It could be extended to optimize both spacings and lengths as well; however, with the level of computer power available to most Amateurs, such an optimization of a 32-element Yagi might take considerably longer than we're willing to wait. Therefore, the design must start with some geometry constants determined by the designer's knowledge of antenna designs.

It was found that the Yagi analysis program lacked sufficient accuracy to completely self-optimize a long Yagi. Specifically, the program showed a tendency to make the elements at either end of the antenna longer than desired. In addition, the program would make the elements in the center of the Yagi considerably shorter than would be believable. At the same time, gain figures would become higher than expected. Moreover, the free-running gain optimization would result in an antenna with a low f/b ratio (less than 15 dB). Therefore, it was necessary to go into the design process manually from time to time and correct element lengths that appeared to be out of line. These adjustments were based on real-world experience with designs which were known to work. Final manual element adjustments were made to perform pattern cleanup on the Yagi.

With a good mathematical model in place, the next step was to build and test a real antenna. This is the point where theory meets reality; if an antenna is optimized with even a slightly erroneous model, those errors will surely be designed into the resultant Yagi. A further complication was the use of elements mounted through the boom but insulated. At that time, no reliable element length correction information existed for that method of mounting elements. An additional uncertainty was the fact that very few existing 432-MHz Yagis peaked very close to 432 MHz on the computer. First attempts to build real 24- and 32-element Yagis resulted in antennas which peaked in gain around 444 MHz.

This occurred for several reasons. First, the design was intentionally peaked high in frequency because the Yagis were designed to be used in arrays of up to 16 elements. In addition, at the onset of antenna construction, I expected a much smaller boom correction for insulated through-the-boom elements than the actual correction factor turned out to be. Another set of elements were made 1/16-inch (1.6 mm) longer. This lowered the gain peak to 442 MHz. An additional set of elements were made for the 32-element Yagi again 1/16-inch (1.6 mm) longer. The gain peak moved

another 2 MHz lower to 440 MHz. Both the real antenna and additional computer modeling showed that a 432-MHz Yagi with 3/16-inch (4.8 mm) diameter elements shifted in frequency approximately 1 MHz for each 1/32 inch (0.8 mm) added or subtracted from the elements. Since 1/32 inch is also very close to 1 mm, this becomes a handy rule of thumb for shifting the center frequency of a 432-MHz Yagi for those working in either English or metric units.

boom correction

During this phase of antenna development I examined the boom correction. Three different insulators — the original 424B type (Heyco nylon inserts), the Delrin™ RIW Products type, and the KLM polyethylene type — were tried; all three gave similar, but not identical, results. The amount of capacitance between the element and boom appeared to be the major variable in boom correction. In modeling the effect of the insulated elements mounted through the boom, one can think of the element as an inductor. The boom is looked at as additional inductors in parallel with the center portion of the element. For insulated elements these inductances are capacitively coupled, reducing the amount of parallel inductance. This lowers the amount of boom effect over elements mounted through the boom and not insulated.

Figure 1 describes the boom correction model. An additional complication in the model is an apparent shielding effect that the boom has on the portion of the element which is inside the boom. This increases the boom correction over the amount implied by the simple capacitive/inductive reactance model. The correction I normally use for this type of element mounting is 25 percent of the boom diameter. The effect appears to change slightly with boom diameter. For example, a 0.75-inch (19 mm) boom shows closer to 20 percent correction, while a 1-1/2 inch (38 mm) boom requires nearly 30 percent correction. This non-constant effect was also charted by DL6WU for uninsulated elements mounted through the boom.⁶ The -0.5 dB gain bandwidth of a well-designed Yagi is close to 3 percent, or nearly 14 MHz at 432 MHz. Because of this, one doesn't have to be all that fussy in the exact determination of the boom correction.

square cut end lengthens element

Another impediment to having the computer model come out right the first time is what I call the *element end effect*. This is an apparent effect where a rod element with square cut ends will appear electrically longer than its physical length. I believe the sharp corners at the end of the element cause a field strength concentration; a more even current and field distribution would be obtained by using elements with spherical ends.

This effect is probably negligible below 50 MHz. At 432 MHz, where a 3/16-inch (5 mm) diameter is a

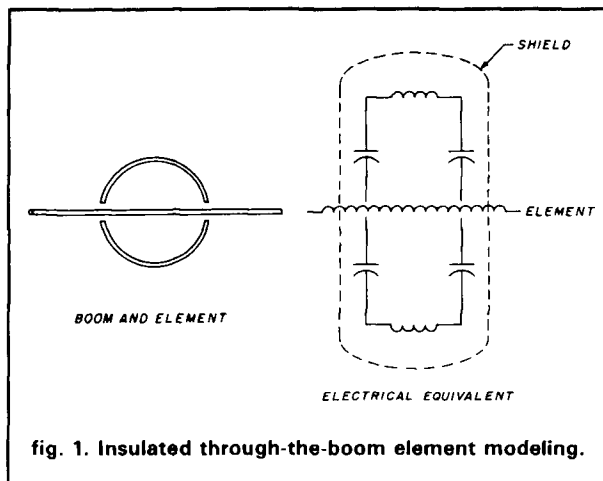


fig. 1. Insulated through-the-boom element modeling.

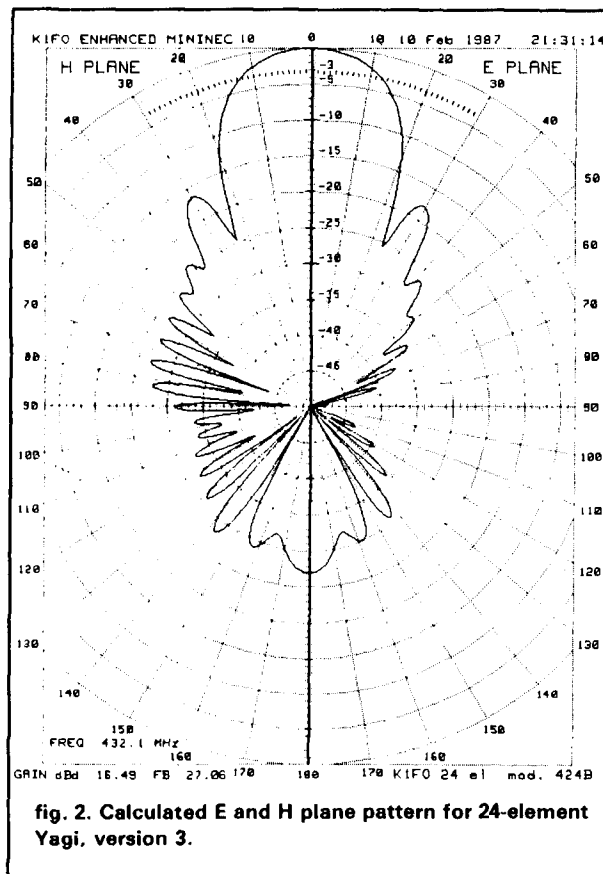


fig. 2. Calculated E and H plane pattern for 24-element Yagi, version 3.

measurable portion of a wavelength, the effect can no longer be ignored. I believe this element end effect is the main reason Amateurs had so much trouble scaling Yagis to 432 and 1296 MHz for many years; it's also further substantiated by persistent stories that the NBS Yagis wouldn't work above 1000 MHz. Most likely the element length graphs provided by NBS did not have this factor taken into account for frequencies significantly different than the 400-MHz test frequency used by the NBS.

MFJ TUNERS

This may be the world's most popular 3 KW roller inductor tuner because it's small, compact, reliable, matches virtually everything and gives you SWR/Wattmeter, antenna switch, dummy load and balun — all at a great price!

Meet "Versa Tuner V". It has all the features you asked for, including the new smaller size to match new smaller rigs—only 10 3/4" W x 4 1/2" H x 14 7/8" D.

Matches coax, balanced lines, random wires—1.8 to 30 MHz. 3 KW PEP—the power rating you won't outgrow (250pf-6KV caps).

Roller inductor with a 3-digit turns counter plus a spinner knob for precise inductance control to get that SWR down to minimum every time.

Built-in 300 watt, 50 ohm dummy load, built-in 4:1 ferrite balun.



MFJ989B **\$349.95**

Lighted Cross-needle Meter reads SWR, forward and reflected power all in one glance. Has 300 and 3,000 watt ranges. Meter light requires 12 VDC.

6 position antenna switch (2 coax lines, through tuner or direct, random/balanced line or dummy load). SO-239 connectors, ceramic feed-throughs, binding post grounds.

Deluxe aluminum low-profile cabinet with sub-chassis for RFI protection, black finish, black front panel with raised letters, tilt bail.

MFJ's Fastest Selling TUNER

MFJ-941D **\$99.95**



MFJ's fastest selling tuner packs in plenty of new features. New styling! Brushed aluminum front. All metal cabinet. New SWR/Wattmeter! More accurate. Switch selectable 300/30 watt ranges. Read forward/reflected power.

New antenna switch! Front panel mounted. Select 2 coax lines, direct or through tuner, random wire/balanced line or tuner bypass for dummy load.

New airwound inductor! Larger more efficient 12 position airwound inductor gives lower losses and more watts out. Run up to 300 RF power output. Matches everything from 1.8 to 30 MHz! dipoles, inverted vee, random wires, verticals, mobile whips, beams, balanced and coax lines.

Built-in 4:1 balun for balanced lines. 1000 V capacitor spacing. Black. 11 x 3 x 7 inches. Works with all solid state or tube rigs. Easy to use anywhere.

MFJ's 1.5 KW VERSA TUNER III

MFJ-962B **\$229.95**



Run up to 1.5 kw PEP and match any feedline continuously from 1.8 to 30 MHz: coax, balanced line or random wire.

Lighted Cross-needle Meter reads SWR, forward and reflected power in one glance. Has 300 and 3,000 watt ranges. 6 position antenna switch handles 2 coax lines, wire and balanced lines. 4:1 balun. 250 pf, 6 kv variable capacitors. 12 position ceramic inductor switch. New smaller size matches new rigs: 10 3/4" x 4 1/2" x 14 7/8" inches. Flip stand for easy viewing. Requires 12V for light.

MFJ's Best VERSA TUNER

MFJ-949C **\$149.95**



MFJ's best 300 watt tuner is now even better! The MFJ-949C all-in-one Deluxe Versa Tuner II gives you a tuner, cross-needle SWR/Wattmeter, dummy load, antenna switch and balun in a new compact cabinet. You get quality conveniences and a clutter-free shack at a super price.

A new cross-needle SWR/Wattmeter gives you SWR, forward and reflected power—all at a single glance. SWR is automatically computed with no controls to set. Has 30 and 300 watt scale on easy-to-read 2 color lighted meter (needs 12 V).

A handsome new black brushed aluminum cabinet matches all the new rigs. Its compact size (10 x 3 x 7 inches) takes only a little room.

You can run full transceiver power output—up to 300 watts RF output—and match coax, balanced lines or random wires from 1.8 thru 30 MHz. Use it to tune out SWR on dipoles, vees, long wires, verticals, whips, beams and quads.

A 300 watt 50 ohm dummy load gives you quick tune ups and a versatile six position antenna switch lets you select 2 coax lines (direct or thru tuner), random wire or balanced line and dummy load.

A large efficient airwound inductor—3 inches in diameter—gives you plenty of matching range and less losses for more watts out. 100 volt tuning capacitors and heavy duty switches gives you safe arc-free operation. A 4:1 balun is built-in to match balanced lines.

Order your convenience package now and enjoy.

2 KW COAX SWITCHES

MFJ-1702 **\$19.95**



MFJ-1702. **\$19.95**. 2 positions. 60 dB isolation at 450 MHz. Less than .2 dB loss. SWR below 1:1.2.

MFJ-1701, **\$29.95**. 6 positions. White markable surface for antenna positions.

\$29.95 MFJ-1701



MFJ's Smallest VERSA TUNER

MFJ-901B **\$59.95**



MFJ's smallest 200 watt Versa Tuner matches coax, random wires and balanced lines continuously from 1.8 thru 30 MHz. Works with all solid state and tube rigs. Very popular for use between transceiver and final amplifier for proper matching. Efficient airwound inductor gives more watts out. 4:1 balun for balanced lines. 5 x 2 x 6 inches. Rugged black all aluminum cabinet.

MFJ's Random Wire TUNER

MFJ-16010 **\$39.95**



MFJ's ultra compact 200 watt random wire tuner lets you operate all bands anywhere with any transceiver using a random wire. Great for apartment, motel, camping operation. Tunes 1.8-30 MHz. 2 x 3 x 4 inches.

MFJ's Mobile TUNER

MFJ-945C **\$79.95**



Designed for mobile operation! Small, compact. Takes just a tiny bit of room in your car. SWR/dual range wattmeter makes tuning fast and easy. Careful placement of controls and meter makes antenna tuning safer while in motion.

Extends your antenna bandwidth so you can operate anywhere in a band with low SWR. No need to go outside and readjust your mobile whip. Low SWR also gives you maximum power out of your solid state rig—runs cooler for longer life.

Handles up to 300 watts PEP RF output. Has efficient airwound inductor, 1000 volt capacitor spacing and rugged aluminum cabinet. 8x2x6 inches. Mobile mounting bracket available for \$5.00.

ORDER ANY PRODUCT FROM MFJ AND TRY IT-NO OBLIGATION. IF NOT SATISFIED, RETURN WITHIN 30 DAYS FOR PROMPT REFUND (less shipping).

• One year unconditional guarantee • Made in USA • Add \$5.00 each shipping/handling • Call or write for free catalog, over 100 products.

MFJ

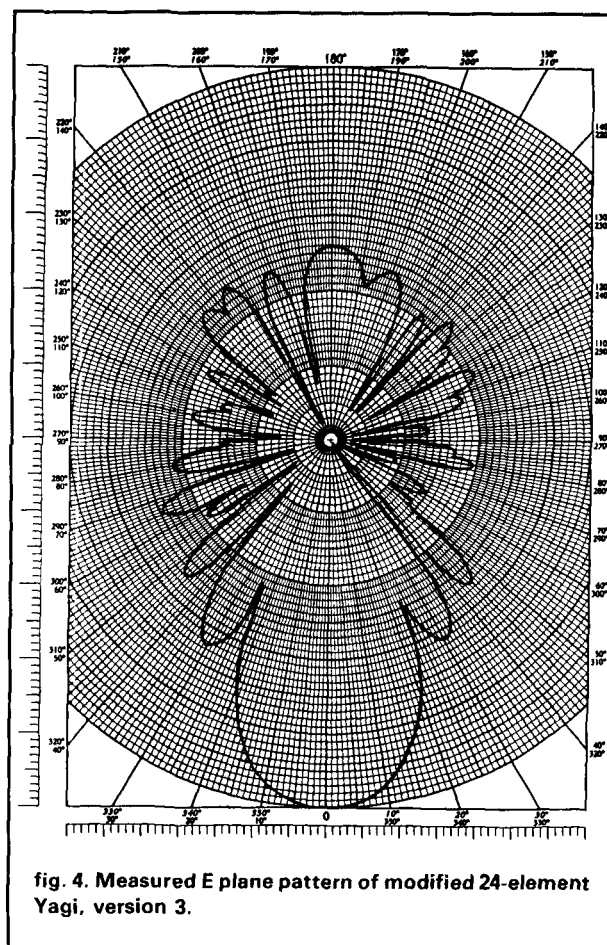
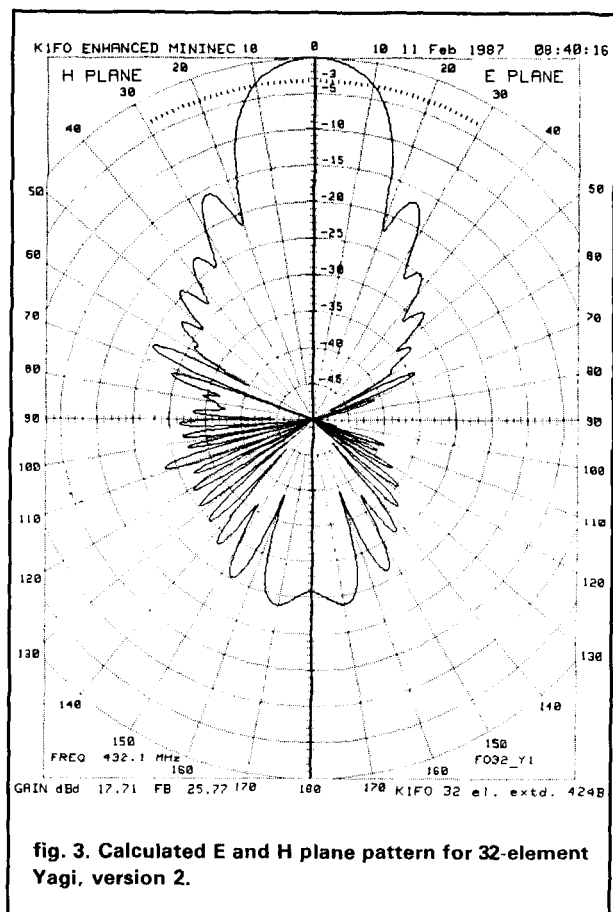
MFJ ENTERPRISES, INC.
Box 494, Mississippi State, MS 39762

TO ORDER OR FOR YOUR NEAREST DEALER, CALL TOLL-FREE

800-647-1800

Call 601-323-5869 in Miss. and outside continental USA Telex 53-4590 MFJ STKV





My work leads me to believe that at 432 MHz, a 3/16-inch (4.8 mm) diameter element with square cut ends acts as if it were close to 0.15 inch (3.8 mm) — electrically longer than its physical length. Using the previously outlined nominal 1-MHz frequency shift per 1/32 inch (0.8 mm) of element length change rule of thumb, this element end effect accounts for close to a 5-MHz lowering in center frequency at 432 MHz. To minimize this effect and to help lower the field concentration at the element ends, I use about a 1/32-inch (0.8 mm) chamfer on the element ends. This appears to reduce the frequency shift to less than 2 MHz. *This rounding of the element ends also appears to help wet weather performance.*

After being sidetracked by the element end effect investigation, it was decided that an additional 1/8 inch (3.2 mm) would be added to the length of all the elements. This would move the gain peak down to 436 MHz. This tuning makes the gain at 432 MHz approximately 0.1 dB lower than the maximum at 436 MHz — the most desired frequency to which the antenna would be tuned — because the pattern at 432 MHz is somewhat cleaner and mutual impedance effects from the other Yagis in arrays would not be detrimental. These mutual impedance effects tend to lower the center frequency of an array of Yagis relative to the

free-space center frequency of a single Yagi.

An array of four medium-sized Yagis (RIW-19s) had both a measured and calculated frequency shift of about 600 kHz. Based on this, an array of 16 Yagis could have a frequency drop of nearly 2 MHz. *If these mutual impedance effects cause the array to move over the high frequency gain dropoff point, the array will never perform as well as expected.* In fact, it is for this reason that some Yagis can never obtain the theoretical 3-dB stacking gain. In addition, the radiation pattern of most Yagis deteriorates rapidly above the gain peak. It is for these reasons that Amateurs were not very successful in getting EME arrays made from some of the early Amateur Yagi designs to work properly.

Computer-generated patterns for the 24-element, 17-foot, 3-inch (5.2 m) and the 32-element, 24-foot (7.3 m) Yagis are given in **figs. 2 and 3**. Actual E plane pattern measurements for both Yagis are shown in **figs. 4 and 5**. A comparison with the patterns of the stock 424B (**figs. 6 and 7**) demonstrates the attention paid to improving the radiation patterns. When comparing the patterns, keep in mind that the revised Yagis use a single reflector instead of the tri-reflector on the

Discover the secret...



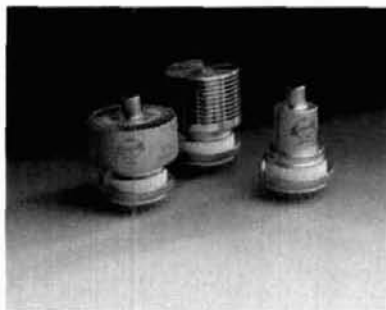
U.S. Navy photo

of Varian EIMAC's 50 Years of Engineering Expertise.

Why do EIMAC tubes deliver more reliable hours of operation than the competition? Look inside the EIMAC 8122W. You'll see a ceramic pin in the top of the grid-screen structure that assures alignment, even under the most strenuous environmental conditions. And you'll note that the grids are made of high-strength molybdenum, not yielding copper. But these improvements don't tell the whole story.

The invisible ingredient built into each EIMAC tube is the careful attention to detail, the continual testing and evaluation, and the engineering know-how that has characterized EIMAC products for over 50 years.

Other members of the EIMAC 8122W long-life family are the 8121W, 8072W, 4657 and the 4662 tube types. Try them in your equipment. You won't see the difference but you will *know* the difference.



For quality, experience and dependability, rely on the Varian EIMAC name. The tradition of excellence lives on.

For more information on the 8122W family of ruggedized tetrodes, call or write, Varian EIMAC. Ask about our 3,000 hour warranty.

Varian EIMAC Division
301 Industrial Way
San Carlos, CA 94070
Telephone: (415) 592-1221



50 Years of Engineering Expertise.

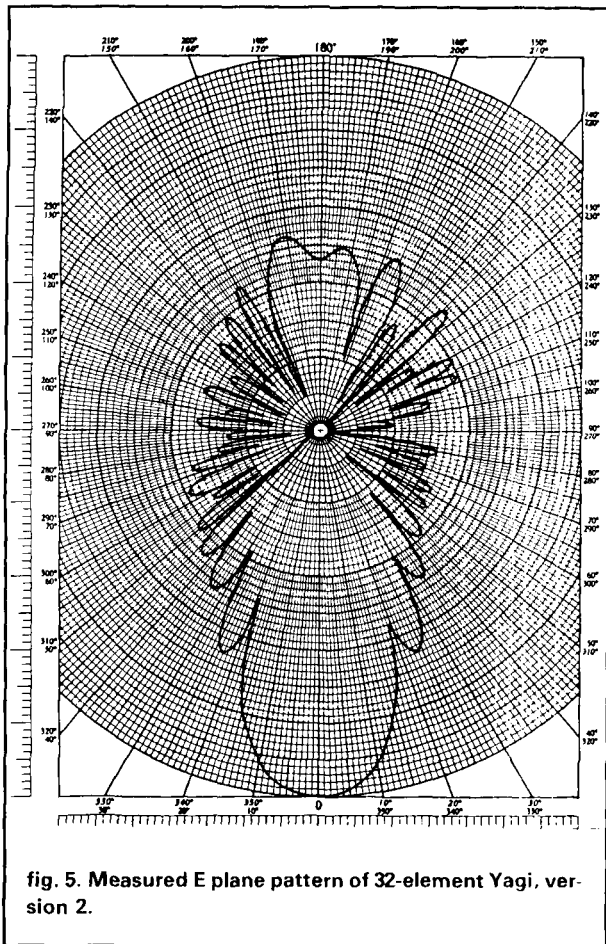


fig. 5. Measured E plane pattern of 32-element Yagi, version 2.

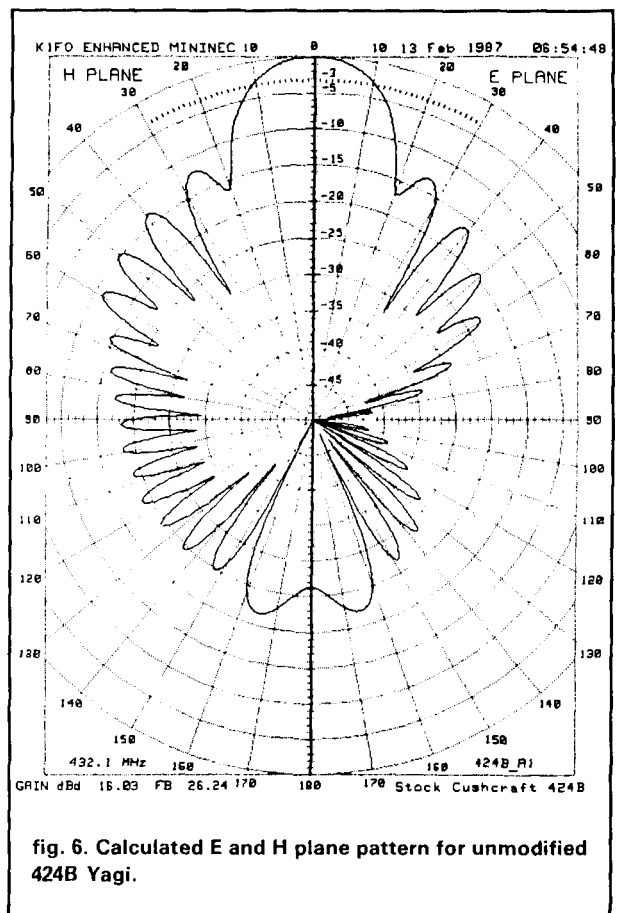


fig. 6. Calculated E and H plane pattern for unmodified 424B Yagi.

original antenna. The calculated gain-versus-frequency plots (fig. 8) provide more interesting data. The maximum gain point of the modified Yagis has been moved 4 MHz higher, to 436 MHz. In addition, the high-side gain cliff, the point at which the gain of the Yagi rapidly drops off, is moved almost 8 MHz higher in frequency. A smooth gain-versus-frequency curve is an indication that the directors are operating in a synergistic mode and hence at or near their maximum possible performance.

Between the 24- and 32-element versions of the Yagis, eight different test Yagis were built before the published dimensions were selected. There's still room for a little improvement in the 32-element Yagi; this will be covered in more detail later.

It's obvious that with the accuracy of antenna analysis programs available to most Amateurs, an important post-computer optimization process is required. One shouldn't put too much confidence in any analysis program until the results have been confirmed with real antennas. With the help of the more sophisticated method of moments analysis programs, I now need only one or two tries building a real antenna to get it right. Getting to this point required two years of

learning both the limitations of the programs I use and more about the design of Yagis.

design procedure

The design cycle is still an iterative process. It first uses a rough optimization using WB3BGU's computer program. Next, the results of the YAGI program are confirmed by a more sophisticated but vastly slower method of moments program. If the design is believable, a test Yagi is made and measured at this point. From that data, further computer tuning is done and other test antennas are made. Figure 9 shows the flow chart for the computer-aided Yagi design process.

The calculated patterns were done on an enhanced version of MININEC. This program's results appear to have gain figures and calculated patterns that more closely represent the real world than those generated by the YAGI program. It should be noted that the calculated gain figures are slightly optimistic because they do not account for balun and element resistive losses, mechanical tolerances, or unwanted radiation from the feed. Likewise, the calculated patterns are also optimistic for the same reasons. One may expect that the real Yagi's sidelobes will be 1 to 2 dB poorer than calculated, with the main lobe slightly narrower than

CONTINUOUS COVERAGE ANTENNAS FOR COMMERCIAL & AMATEUR SERVICE

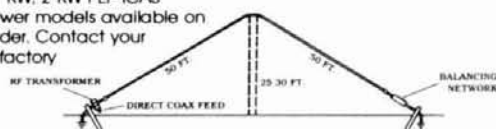
Model AC 1.8-30

1.8 to 30 MHz

- SWR Max 2:1, 1.4:1 average from 1.8 to 30 MHz
- Can be installed in approximately 80 ft. space
- Ideal for commercial services for multi frequency operation without the need for antenna tuners or additional antennas
- Handles 1 KW, 2 KW PEP ICAS
- Higher power models available on special order. Contact your dealer or factory

\$159.50

SHIPPING & HANDLING
ADD \$4.00



U.S. Patent No. 4,511,898

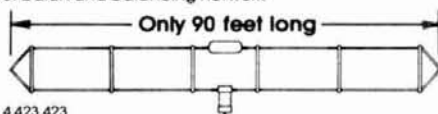
Model AC 3.5-30

3.5 to 30 MHz

- SWR less than 2:1 from 3.5 to 30 MHz
- Complete assembled. Balun terminated with standard SO-239 connector
- Power capability 1 KW - 2 KW PEP ICAS. Higher power model is available on special order.
- Designed for 50 ohm feedline
- Weather proof balun and balancing network

\$167.50

SHIPPING & HANDLING
ADD \$4.00



U.S. Patent No. 4,423,423

ALL OUR PRODUCTS MADE IN USA



BARKER & WILLIAMSON

Quality Communication Products Since 1932

At your Distributors. Write or Call.

10 Canal Street, Bristol, PA 19007

(215) 788-5581

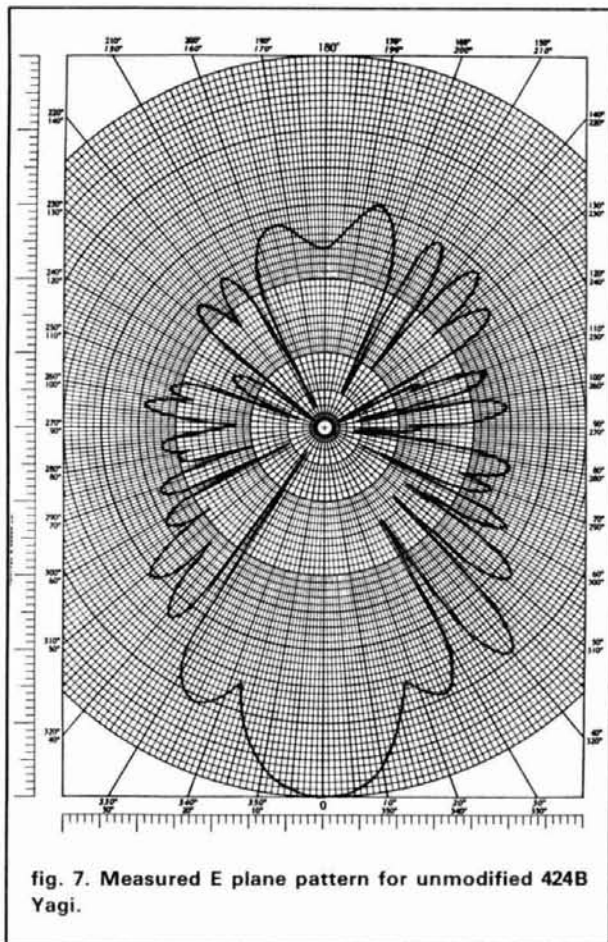


fig. 7. Measured E plane pattern for unmodified 424B Yagi.

calculated and gain typically 0.1 dB lower than calculated.

Careful comparative gain measurements between these Yagis and both the RIW-19 Yagi (14.9 dBd) and the KLM 432-30-LBX Yagi (17.3 dBd) indicate that the 32-element version 2 Yagi has 17.7 dBd forward gain and the 24-element model has about 16.4 dBd gain, or 0.5 dB over the original 424B. Computer analysis by both the WB3BGU program and the more sophisticated method of moments programs agrees with these gain comparisons. As a reference, a 31-element, 24-foot (7.3 m) DL6WU design Yagi measures 17.5 dBd and has a slightly poorer pattern. The optimized 31-element DL6WU design for which I calculated the revised element lengths has a slightly better pattern than the 32-element version 2 Yagi, but lower gain at 17.6 dBd.⁷ The improved 32-element design (version 3) theoretically has as good an overall pattern as the optimized DL6WU design, but with almost 0.2 dB higher forward gain. Accuracy of these gain figures should be within 0.2 dB.

I believe that the maximum theoretical gain that can be obtained with a 17-foot (5.2 m) 432-MHz Yagi is 16.6 dBd and that the maximum for a 24-foot (7.3 m)



INTERNATIONAL MONTHLY MAGAZINE BY AND FOR ACTIVE RADIOAMATEURS

Radiosporting

THIS IS IT! - FOR BIG GUNS & LITTLE PISTOLS

A magazine dedicated to quality and sportsmanship in amateur radio operating. Fresh, timely, practical and down to earth reading for little pistols and big guns. Written by the world's best in their fields: ON4UN, SMØAGD, LZ2CJ, VE3BMV, KH6BZF, DJ9ZB, ZS6BRZ, W1WY, N2AU, K7GCO, K4ZN, W4GF, VE3JTQ, WB4ZNH, WB9TBU, KQ2M, NS6X, W3FG, KA3B, K1PLR, N7CKD, VE3XN, ABØX, JE1CKA and others.

Includes DX News, QSL Info, 160m, 80m, 10m, 6m columns, DXpeditioning, Propagation, Awards, Contest rules and results, Traffic - Emergency, FCC News, New Products, Antennas, Technical news and articles, equipment reviews and modifications, computer programs, Radio Funnies, Club Life, RTTY, VHF/UHF, Mail Box, Classified Ads and much more in a magazine format with the speed of a bullet.

RADIOSPORTING sponsors DX Century Award, Contest Hall of Fame and World Radio Championship contest.

"Your publication is superb! Keep it up!" Joe Reisert, W1JR

"Your W2PV articles are priceless. Your magazine is super!"

Rush Drake, W7RM

"Let me congratulate you on a very impressive magazine. Just what I've been looking for as a DXer and Contester!"

Dick Moen, N7RO

"RADIOSPORTING, once received, cannot be tossed aside until it is read from cover to cover. Then reviewed again and again."

Chas Browning, W4PKA

Subscription rates: 1 year USA \$18, Canada CDNS26, Overseas US\$23; 2 years \$33, \$48, \$42 respectively. Single issue \$2. USA First Class Mail add \$8/year, DX Air Mail add \$15/year.

TRY US! SUBSCRIBE OR SEND \$1 FOR YOUR SAMPLE COPY.

RADIOSPORTING Magazine

PO Box 282, Pine Brook, NJ 07058, USA



Yagi is 18.0 dBd. Thus, these Yagis are near the theoretical maximum possible gain, given their boom-lengths. Further performance increases would require radical changes in element spacings, and therefore defeat the objective of devising an improved antenna that was easy to build from an existing commercial model. These theoretical gain improvements are also very small (approximately 0.2 dB). Keep in mind that a measured gain of 18.0 dBd for a 24-foot (7.3 m) 432-MHz Yagi may never be obtained because of resistive losses, construction tolerances, unwanted feed radiation, and feed imbalance. Although the original design objective was to create an easy-to-copy modification of a commercial Yagi, the above performance comparison indicates that the design is worthy enough to be considered for construction from scratch. This is verified by the fact that the 32-element, 24-foot (7.3 m) design has never been beaten at an antenna gain contest by a similar size Yagi. The only Yagi ever to exceed its gain at an antenna contest was almost 29 feet (8.8 meters) long, which is 5 feet (1.5 meters) longer in boomlength.

Spacing	Length	Boom (inches)	
1.000,	13.6250	1	REF
5.250,	13.2500	1	DE
7.875,	12.6250	1	D1
11.563,	12.2500	1	D2
16.813,	12.1875	1	D3
23.563,	12.0625	1	D4
31.875,	11.8750	1	D5
42.125,	11.6875	1	D6
52.375,	11.5625	1	D7
62.625,	11.3750	1	D8
72.875,	11.3125	1 1/8	D9
83.125,	11.2500	1 1/8	D10
93.375,	11.1875	1 1/8	D11
103.625,	11.1250	1 1/8	D12
113.875,	11.0625	1 1/8	D13
124.125,	11.0000	1 1/8	D14
134.375,	11.0000	1 1/8	D15
144.625,	10.9375	1	D16
154.875,	10.8750	1	D17
165.125,	10.8750	1	D18
175.375,	10.8125	1	D19
185.625,	10.8125	1	D20
195.875,	10.7500	1	D21
206.125,	10.7500	1	D22

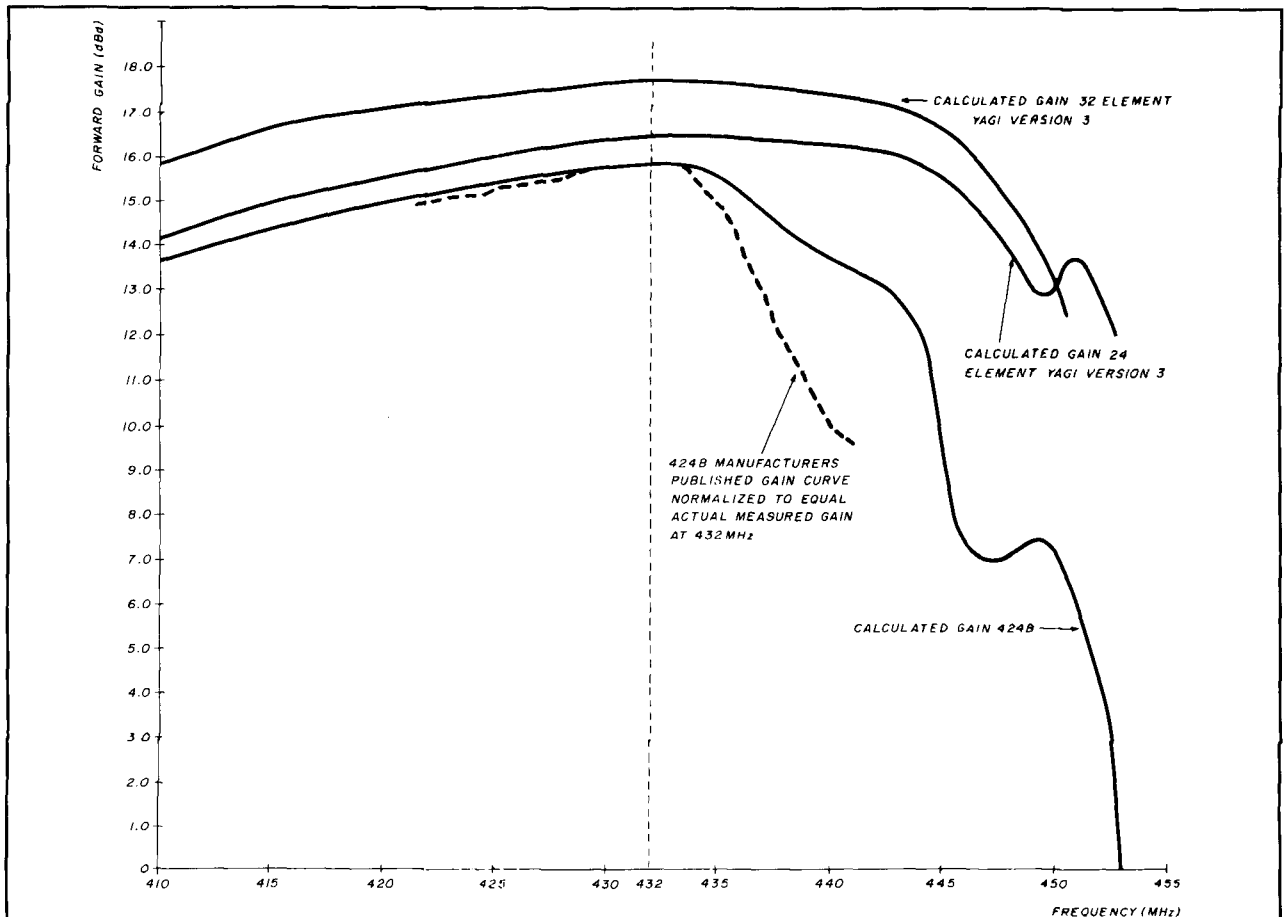


fig. 8. Calculated gain versus frequency is higher than actual gain, since 100 percent power transfer is assumed at all frequencies — i.e., feed impedance changes are ignored.

HIGH PERFORMANCE PRESELECTOR-PREAMP

The solution to most interference, intermod, and desense problems in **AMATEUR** and **COMMERCIAL** systems.



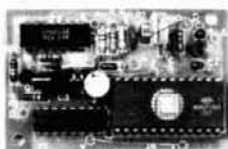
- 40 to 1000 Mhz - tuned to your frequency
- 5 large helical resonators
- Low noise - High overload resistance
- 8 dB gain - ultimate rejection > 80 dB
- 10 to 15 volts DC operation
- Size - 1.6 x 2.6 x 4.75" exc. connectors
- **FANTASTIC REJECTION!**

Typical rejection:
±600 KHz@144 Mhz: -28dB
±1.6 Mhz@220 Mhz: -40dB
±5 Mhz@450 Mhz: -50dB

Price - CALL bipolar w/RCA jacks
Connector options: BCN \$5, UHF \$6,
N \$10
SUPER HOT! GaAs Fet option \$20

AUTOMATIC IDENTIFIERS

ID-1



ID-2



- For transceivers and repeaters - **AMATEUR** and **COMMERCIAL**
 - Automatic operation - adjustable speed and amplitude
 - Small size - easy installation - 7 to 15 volts DC
 - 8 selectable, reprogrammable messages - each up to 2 min. long
 - Wired, tested, and programmed with your message(s)
- Model ID-1 - \$49.95 Model ID-2 w/2 to 10 minute timer - \$69.95

We offer a complete line of transmitter and receiver strips and synthesizers for amateur and commercial use.

Request our free catalog. Allow \$2 for UPS shipping - Mastercard and VISA welcome

GLB ELECTRONICS, INC.

Dept H, 151 Commerce Pkwy., Buffalo, NY 14224
716-675-6740 9 to 4

ICOM DAY

presented by



VHF COMMUNICATIONS

915 North Main Street
Jamestown, New York 14701
(716) 664-6345

Western New York's finest
Amateur dealer at the

BATAVIA HAMFEST SUNDAY, JULY 12th

at the Alexander
Fireman's Grounds
Rt. 89, South of Batavia, NY

WIN!!! IC-u2AT plus hourly prizes

No purchase necessary.
ICOM personnel on hand to
answer your questions . . .

**SPECIAL PRICES
ON ALL
ICOM EQUIPMENT**

✓ 157

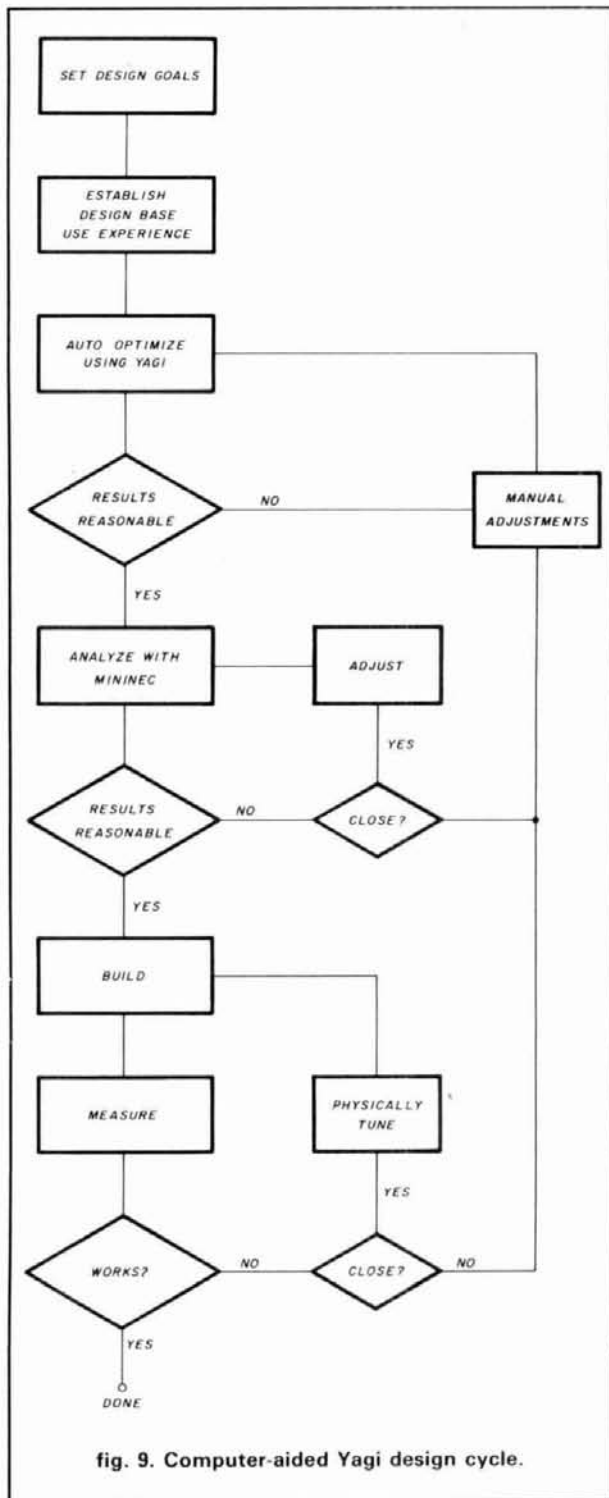


fig. 9. Computer-aided Yagi design cycle.

construction

The actual construction of either of these Yagis starts with the drilling of three new element holes in the boom. The driven element is mounted in a new hole 2.625 inches (66.7 mm) behind the original driv-

an element hole. The old DE location now becomes director 1 and the original director 1 is now director 2. A second new hole is drilled for director 3. The original director 2 hole is no longer used and a final new element hole is added between the original director 2 and 3 holes where a new director 4 now goes. This provides a new antenna with 24 elements — the same number as the original 424B.

The improved Yagis use a single reflector instead of the 424B's tri-reflector. Thus two additional close-spaced directors are added in the new design. A new hole for the N connector bracket is drilled 2.625 inches (66.7 mm) behind the original. The hole for the balun clamp is moved 3.125 inches (79 mm) further back to accommodate the shortened baluns used on the modified Yagis. **Figure 10** shows the new hole drilling pattern for the rear boom section. This revised element spacing is common to both the 24-element and 32-element versions.

Constructing a 24-element Yagi from an unassembled 424B requires only 27 inches (0.69 m) of 3/16-inch aluminum rod and 2 inches (5 cm) of No. 12 copper wire. Modifying an assembled 424B requires the same parts plus a number of element retainers to replace those which will be destroyed in disassembly. One should note that most of the directors could be filed down while in place on the boom, provided that one was careful in checking dimensions during the filing process. It's easier, however, if the element lengths are checked carefully when they're removed from the Yagi. Cutting tolerance should be kept within $\pm 1/32$ inch (0.8 mm), for reassembly of an existing 424B, suitable stainless steel element retainers (No. 6100-18) made by Industrial Retaining Ring Company of Irvington, New Jersey, can be ordered from most local industrial hardware distributors. Suitable retainers can also be ordered from Cushcraft.

Table 1 is a list of the dimensions for the new element lengths of the 24-element Yagi. There are few common dimensions with the original 424B. No attempt was made to save existing element lengths.

The listed dimensions are for version 3 of the 24-element Yagi; they supersede any information I distributed before August, 1986. The version 3 Yagi incorporates additional element adjustments which were modeled on MININEC and confirmed on a test antenna. The latest version features improvements in both gain and pattern. Be sure to put a slight chamfer on the end of the elements — otherwise the antenna will tune lower in frequency and the driven element match may not be acceptable.

The driven element is described in **fig. 11**. Note that the rectangular black spacer insulators used between the driven element and T match bars are no longer used. The No. 16 wire used to connect the T match to the N connector is replaced by a No. 12 wire. This

was done both to improve the VSWR bandwidth and reduce unwanted radiation from the jumper wire. Measurement of a stock 424B gave a VSWR of 1.15:1 when dry and over 10:1 when doused with water from a garden hose. The revised match arrangement on the modified Yagi has a VSWR less than 1.12:1 when dry and about 2.0:1 (measured at the feed) when drenched with water.

When radiation patterns were first made on the modified Yagis, an imbalance in the sidelobes was noted. A similar pattern distortion was also measured on a stock 424B. Several more measurements were made to determine whether the pattern distortions were occurring in the measurement method or were actually in the Yagis. To confirm that the imbalance was really in the antenna, the test 424B was flipped over. The pattern imbalance changed sides when the Yagi was turned over. This indicated that the pattern distortion was in the antenna and not attributable to range reflections.

After checking a number of possible causes for the imbalance, it was determined that the balun on the 424B was 1.00 inch (25.4 mm) too long. A length error of exactly 1.00 inch (25.4 mm) leads me to believe that the error in balun length was due to a simple number translation mistake when the 424B's designer calculated the balun length, and that it wasn't made that length intentionally. The main objective of a half-wavelength balun is to provide a 180-degree phase shift to feed the other half of the drive element. The actual length of the balun should be 180 electrical degrees, including the ends of the balun that protrude from the shield. One should not change the length of the balun to obtain a good match; this will cause pattern distortion. The shorter balun also appears to help the wet weather VSWR. If you don't shorten the balun, the driven element dimensions will be different for a proper match.

designing (and mounting) a longer Yagi

The success of the 24-element, 17-foot (5.2 m) Yagi inspired a longer version. The design objective of the long Yagi was simply to outperform any available commercial or homemade Yagi. The appearance of the 22-foot (6.7 m) KLM 432-30-LBX, based upon the DL6WU design (with 17.3 dBd gain), plus the increasing use of homemade DL6WU Yagis up to 24 feet (7.3 meters) long, added to the challenge. A secondary design objective of the longer version was to make it from readily available parts.

A 24-foot (7.3 m) length was selected because I believed it to be a practical size limit, so the Yagi would be reasonably easy to handle. While longer Yagis may appear practical on paper, the construction of an EME array, which requires elevation movement, places

Table 2. Dimensions for a 32-element Yagi, version 2.

Spacing	Length	Boom (inches)	
1.000,	13.9375	1	REF
5.250,	12.8750	1	DE
7.875,	12.9375	1	D1
11.563,	12.3750	1	D2
16.813,	12.3750	1	D3
23.563,	12.2500	1	D4
31.875,	12.0625	1	D5
42.125,	11.8750	1	D6
52.375,	11.7500	1	D7
62.625,	11.5625	1	D8
72.875,	11.3750	1 1/8	D9
83.125,	11.3750	1 1/8	D10
93.375,	11.3750	1 1/8	D11
103.625,	11.3125	1 1/8	D12
113.875,	11.0625	1 1/8	D13
124.125,	11.0625	1 1/8	D14
134.375,	11.1250	1 1/4	D15
144.625,	11.1250	1 1/4	D16
154.875,	10.9375	1 1/8	D17
165.125,	10.9375	1 1/8	D18
175.375,	10.9375	1 1/8	D19
185.625,	11.0000	1 1/8	D20
195.875,	10.9375	1 1/8	D21
206.125,	10.9375	1 1/8	D22
216.375,	10.8125	1 1/8	D23
226.625,	10.8125	1	D24
236.875,	10.8125	1	D25
247.125,	10.8125	1	D26
257.375,	10.8125	1	D27
267.625,	10.8750	1	D28
277.875,	10.8750	1	D29
288.125,	10.8125	1	D30

Table 3. Dimensions for a 32-element Yagi, version 3 (not tested).

Spacing	Length	Boom (inches)	
1.000,	13.6250	1	REF
5.250,	12.9375	1	DE
7.875,	12.7500	1	D1
11.563,	12.3125	1	D2
16.813,	12.3125	1	D3
23.563,	12.1875	1	D4
31.875,	12.0000	1	D5
42.125,	11.8125	1	D6
52.375,	11.6875	1	D7
62.625,	11.5000	1	D8
72.875,	11.3438	1 1/8	D9
83.125,	11.3438	1 1/8	D10
93.375,	11.3438	1 1/8	D11
103.625,	11.2813	1 1/8	D12
113.875,	11.0938	1 1/8	D13
124.125,	11.0313	1 1/8	D14
134.375,	11.0625	1 1/4	D15
144.625,	11.0000	1 1/4	D16
154.875,	10.9688	1 1/8	D17
165.125,	10.9688	1 1/8	D18
175.375,	10.9063	1 1/8	D19
185.625,	10.9063	1 1/8	D20
195.875,	10.9063	1 1/8	D21
206.125,	10.8438	1 1/8	D22
216.375,	10.8438	1 1/8	D23
226.625,	10.8125	1	D24
236.875,	10.7500	1	D25
247.125,	10.7500	1	D26
257.375,	10.7500	1	D27
267.625,	10.7500	1	D28
277.875,	10.6875	1	D29
288.125,	10.6875	1	D30

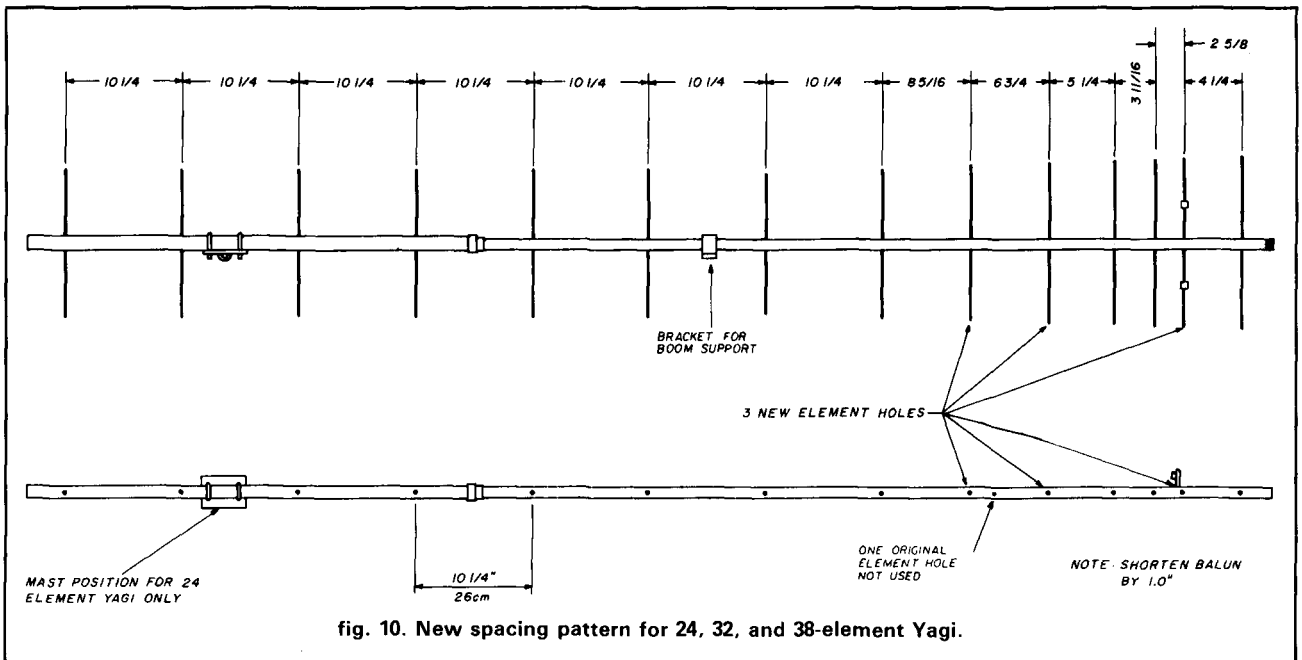
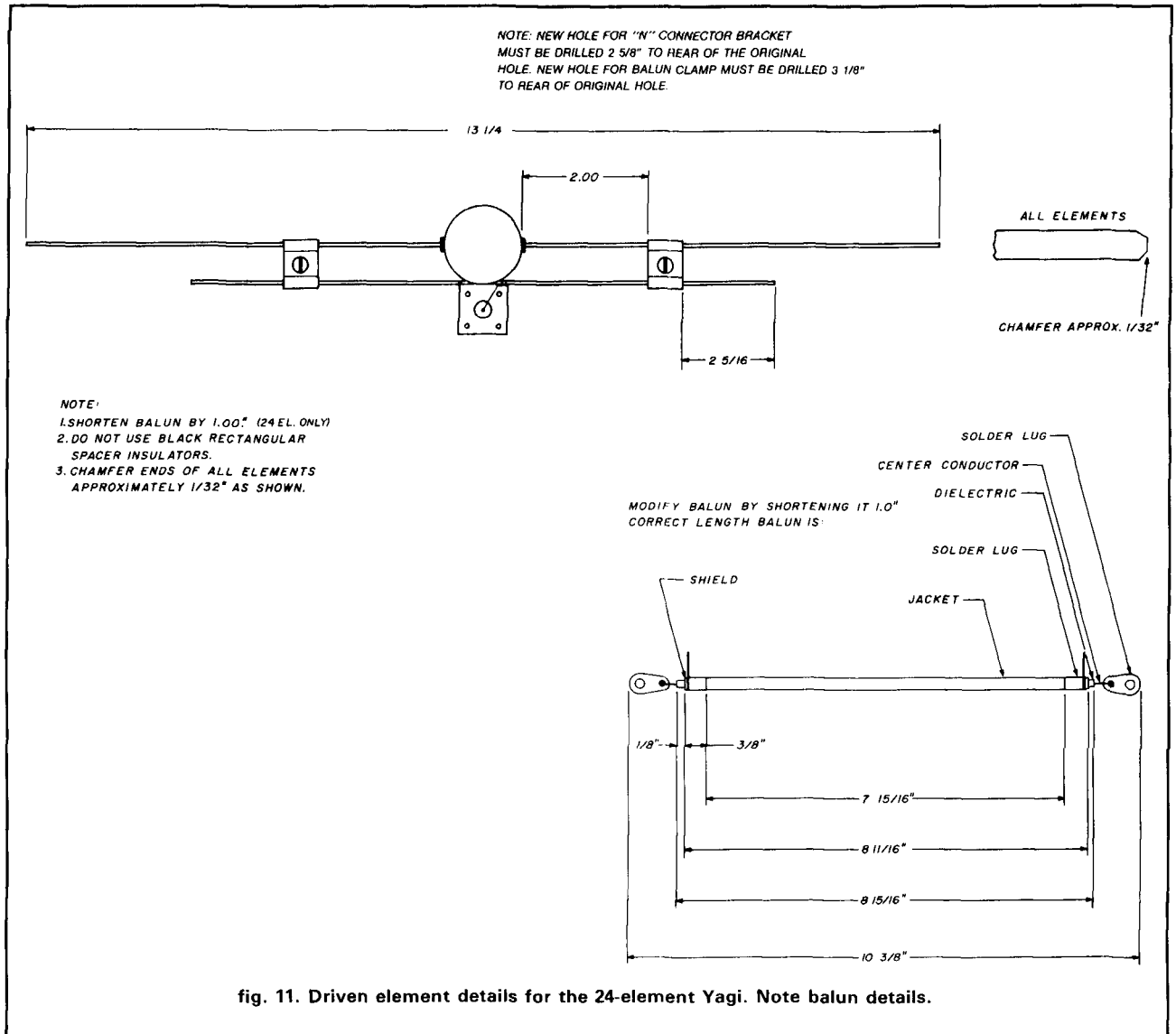


fig. 10. New spacing pattern for 24, 32, and 38-element Yagi.



additional demands on the supporting tower. Typical EME arrays are mounted about 20 feet (6.1 meters) above the ground; an array of 16 of the 24-foot (7.3 meters) long Yagis has only 4 feet (1.2 meters) of ground clearance when tilted back. Longer Yagis will need a higher tower and hence one that is considerably stronger than the commonly used Rohn 45. If an array of such long Yagis is intended to be mounted atop a tall guyed tower, for use on tropo, for example, the design becomes more difficult. An array made from even longer Yagis would have to be mounted a large distance above the top guy wires in order to allow elevation movement. In the case of an array made from 24-foot (7.3 meters) Yagis, the height above the guys is 14 feet (4.3 meters). An array made from eight of the Yagis stacked two wide and four high has a total windswept area of over 40 square feet when phasing lines, preamplifier enclosure, and all other required

accessories are included. Such an array presents a loading force that is at the limit of what a Rohn 55 can handle. When one considers that an array of eight 29-foot (8.8-meter) Yagis has a wind area approaching 50 square feet and would have to be mounted over 16 feet (4.9 meters) above the guys, one can see how quickly the tower loading can get out of hand.

The 24-foot (7.3-meter) length worked out well because it could be obtained by purchasing an additional center boom section for the 424B from Cushcraft. The availability of the additional boom section, in pre-drilled form, sealed the design length. To complete the boom only a simple, short, 1-1/4 inch (38 mm) OD, 0.058-inch (1.5 mm) wall, 6061-T6 aluminum tube splice was required.

Those who build the Yagi may note that it could have been made with an additional director (10.25 inches/260 mm longer). I decided to keep the anten-

Wide Dynamic Range and Low Distortion – The Key to Superior HF Data Communications

- Dynamic Range > 75 dB
- 400 to 4000 Hz
- BW Matched to Baud Rate
- BER < 1×10^{-5} for S/N = 0 dB
- 10 to 1200 Baud
- Linear Phase Filters



ST-8000 HF Modem

Real HF radio teleprinter signals exhibit heavy fading and distortion, requirements that cannot be measured by standard constant amplitude BER and distortion test procedures. In designing the ST-8000, HAL has gone the extra step beyond traditional test and design. Our noise floor is at -65 dBm, not at -30 dBm as on other units, an extra 35 dB gain margin to handle fading. Filters in the ST-8000 are all of linear-phase design to give minimum pulse

distortion, not sharp-skirted filters with high phase distortion. All signal processing is done at the input tone frequency; heterodyning is NOT used. This avoids distortion due to frequency conversion or introduced by abnormally high or low filter Q's. Bandwidths of the input, Mark/Space channels, and post-detection filters are all computed and set for the baud rate you select, from 10 to 1200 baud. Other standard features of the ST-8000 include:

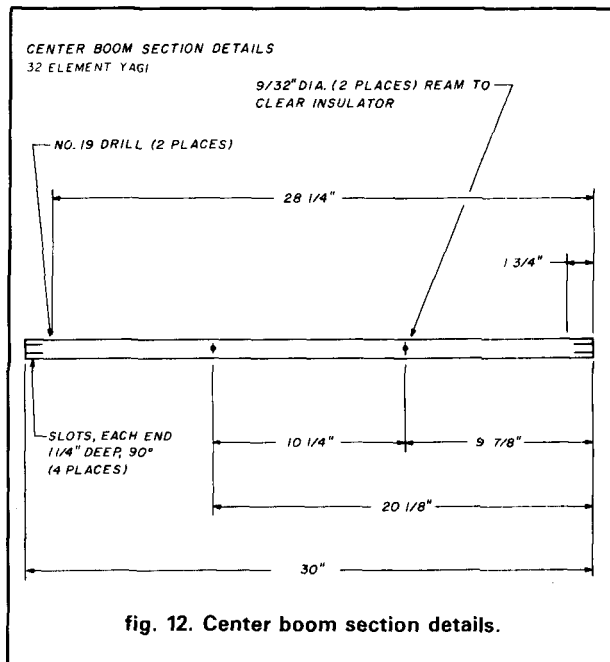
- 8 Programmable Memories
- Set frequencies in 1 Hz steps
- Adjustable Print Squelch
- Phase-continuous TX Tones
- Split or Transceive TX/RX
- CRT Tuning Indicator
- RS-232C, MIL-188C, or TTL Data
- 8, 600, or 10K Audio Input
- Signal Regeneration
- Variable Threshold Diversity
- RS-232 Remote Control I/O
- 100-130/200-250 VAC, 44-440 Hz
- AM or FM Signal Processing
- 32 steps of M/S filter BW
- Mark or Space-Only Detection
- Digital Multipath Correction
- FDX or HDX with Echo
- Spectra-Tune and X-Y Display
- Transmitter PTT Relay
- 8 or 600 Ohm Audio Output
- Code and Speed Conversion
- Signal Amplitude Squelch
- Receive Clock Recovery
- 3.5" High Rack Mounting

Write or call for complete ST-8000 specifications.



HAL Communications Corp.

Government Products Division
Post Office Box 365
Urbana, Illinois 61801
(217) 367-7373 TWX 910-245-0784



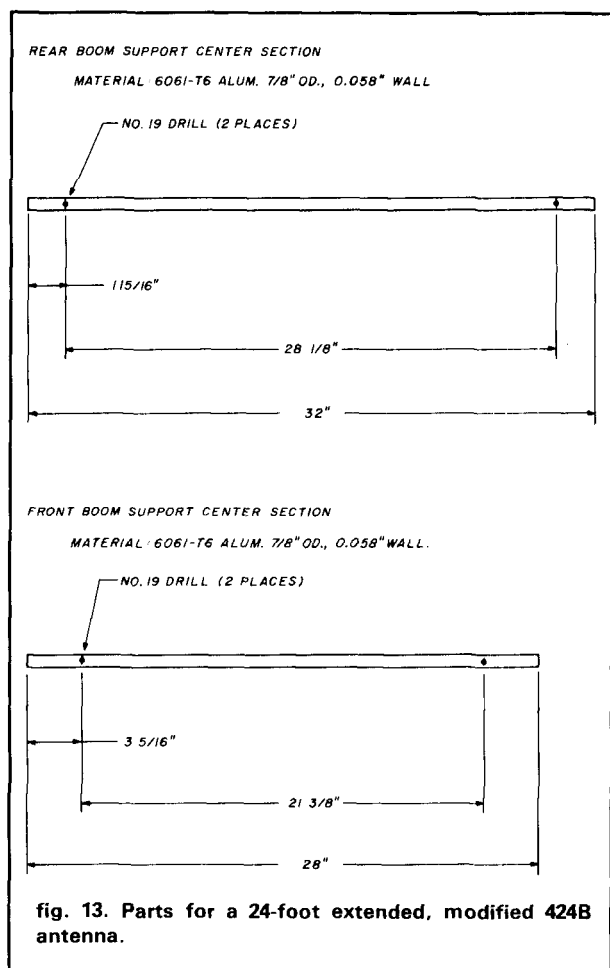
na at 32 elements and overlap the rear and center boom sections for additional strength. The selected length and mast mounting position creates a balanced antenna when a feedline is attached. Having a balanced antenna is an important consideration, especially when it will be used in large arrays. The center boom piece is detailed in **fig. 12**.

The longer, 24-foot (7.3-meter) length made the original Cushcraft 424B boom support inadequate. A solution was again found in Cushcraft parts. A new boom support was made from preformed boom support pieces for the 220B antenna. This required only the fabrication of two simple straight splice sections of 3/4-inch (19-mm) OD, 0.058-inch (1.5-mm) wall aluminum tube. The new boom support center pieces are described in **fig. 13**.

Alternately, one can make one's own boom supports. Another possibility would be to lengthen the original 424B supports by using 0.625-inch OD, 0.058-inch wall aluminum tubing. Since the parts for the new boom support were purchased, Cushcraft changed the design of its boom supports. Suitable boom supports can now also be made from the supports used on either the latest A32-19 or 4218-XL 144-MHz Yagis. A rigid boom support is preferable to a simple support wire; it adds lateral strength to the boom, minimizing oscillation in the wind.

Element lengths for the 32-element version 2 Yagi are given in **table 2**. These are the latest tested dimensions and are representative of the version that's been brought to several antenna contests and also used in NC11's EME array. The director lengths, which don't get progressively shorter, may not seem logical, but I found that this length arrangement was necessary to keep an acceptable pattern, given the closer-than-desired director spacing used in the 424B boom sections.

Since the version 2, 32-element Yagi was perfected, access to more sophisticated computer programs has allowed an improved director string to be calculated. The new director arrangement uses an element length scheme similar to the version 3, 24-element Yagi. That is to say, all directors are shorter than the preceding one. This new director string theoretically has 0.1 dB more gain than the version 2 arrangement. The pattern is also slightly cleaner, in theory. Dimensions for the new arrangement called version 3 are given in **table 3**. These dimensions haven't been confirmed by the construction and measurement of test antennas. Experience with the version 3, 24-element Yagi makes me confident that the revised 32-element design will perform as predicted. One can never be completely certain that it will perform as expected until a real antenna is built and measured. The design data for all of these Yagis is presented here because publishing my work up to this point was long overdue. One



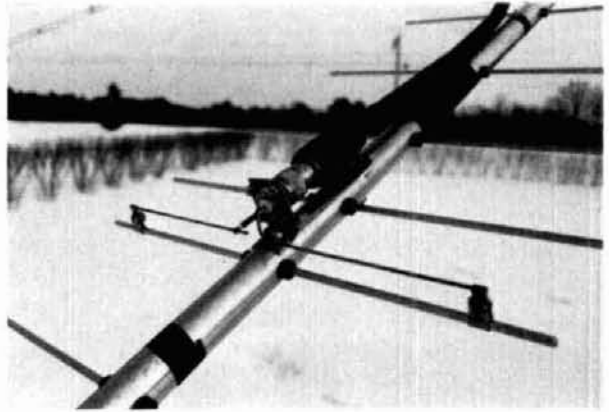
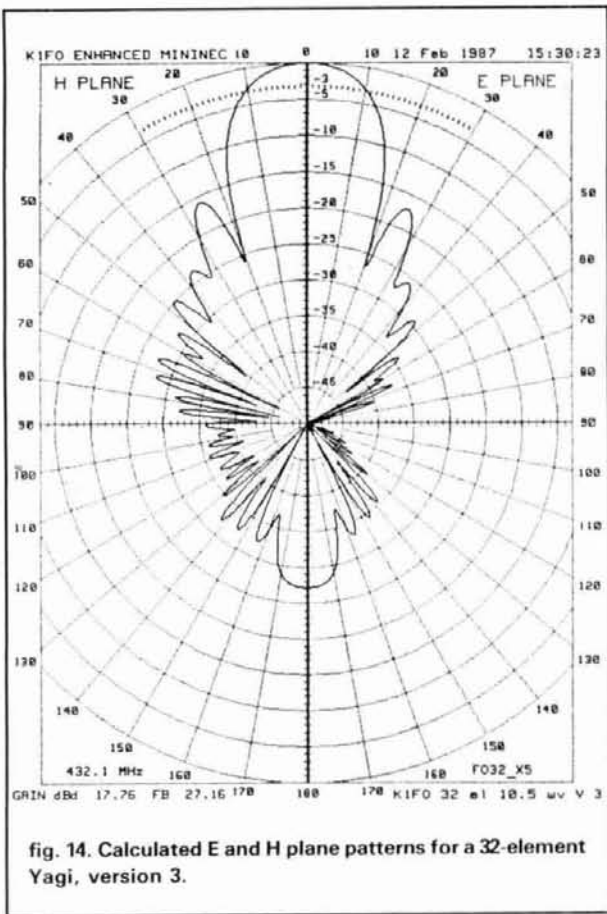
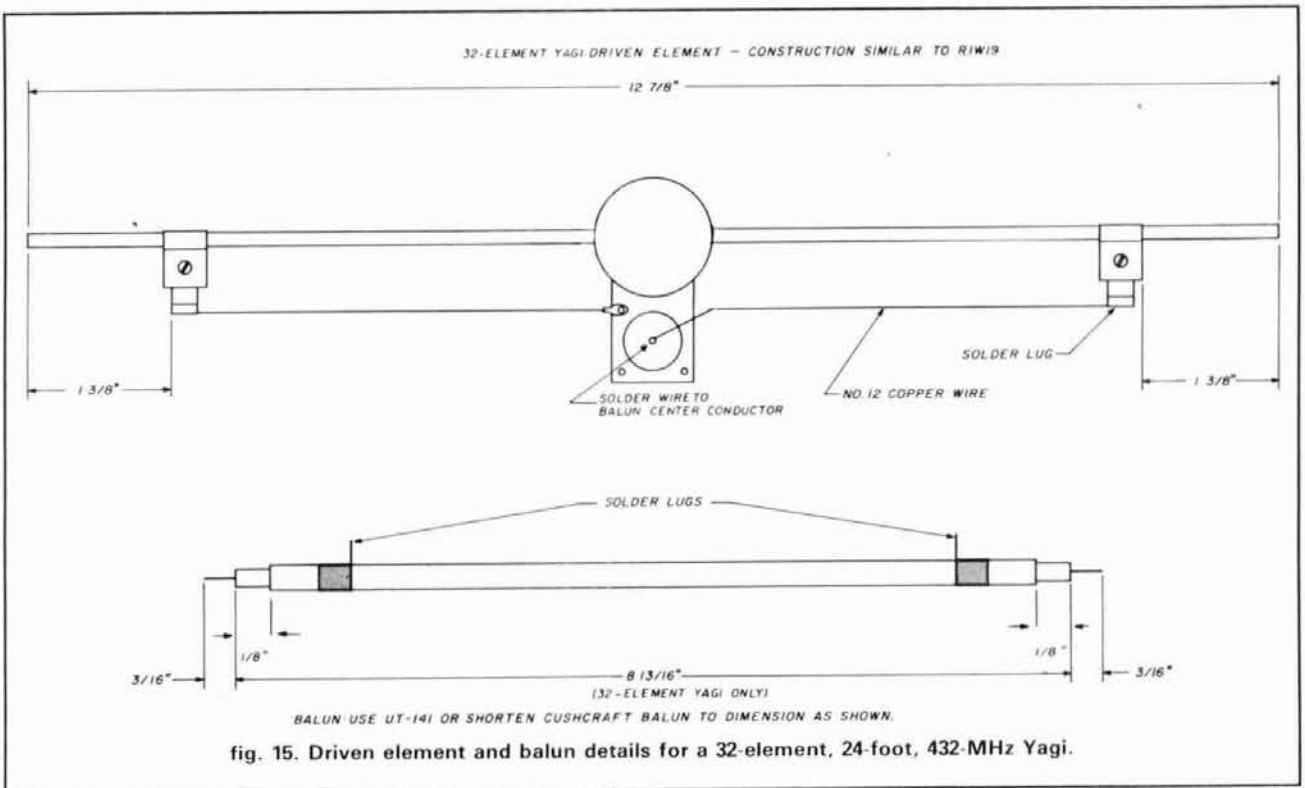


Photo A. Thirty-two element Yagi driven element.

could become consumed in a lifetime project to continually improve upon the last design. If such a cycle were to continue forever — without publishing any of the earlier work — there would be no benefit to the Amateur community. However, be forewarned that if you decide to build a Yagi using the **table 3** dimensions, you'll be entering uncharted territory. Calculated E and H plane patterns for the version 3 Yagi are given in **fig. 14**.

The maximum performance objective for the 24-foot (7.3-meter) Yagi also required a new driven element construction. I felt that the 424B-based driven element had excessive, unwanted radiation from the



wire between the N connector and T match bars. To remedy this situation, a driven element patterned after that used on the RIW Products 19-element 432-MHz Yagi was made, moving the N connector closer to the boom. This has been done both by cutting down the Cushcraft-supplied connector brackets and also by making copies of the brackets employed on RIW Products' Yagis. The new T match uses No. 12 copper wires, as does the RIW Yagi. A UT-141 balun was used, replacing the Cushcraft RG-303 balun. The Yagi with the new T match appears to have close to 0.1 dB more gain than one with the modified Cushcraft match. Either match can be used on either version of the antenna. The builder will have to decide if the less than 0.1 dB gain increase is worth the added effort. Those perfectionists in the audience may note that the UT-141 balun accounts for about 0.05-dB loss. A larger size copper hardline such as UT-225 or a sleeve balun could be fabricated if one finds that loss upsetting. Construction details of the new T match for the 32-element Yagi can be found in **fig. 15** (see

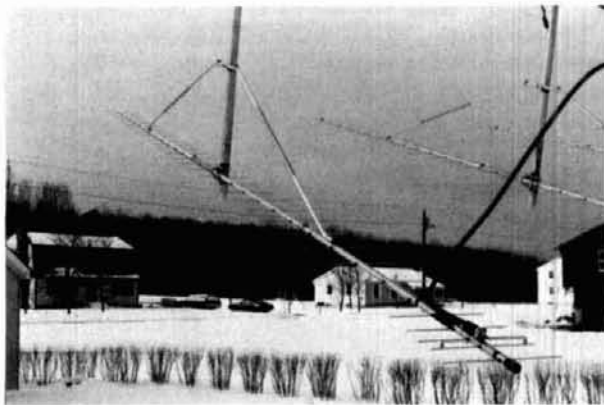


Photo B. Thirty-two element, 24 foot Yagi.

Photo A). The boom layout for the 32-element Yagi is shown in **fig. 16** and **Photo B**.

There are sure to be some operators who won't be satisfied with a 24-foot Yagi. For those adventurous souls, element lengths for a 38-element, 29-foot version (see **fig. 17**) are given in **table 4**. The expected gain of this 38-element model is 18.5 dBd. If you attempt to build the 38-element version, please keep in mind that because I haven't built or tested this version, I won't be able to give advice on the construction of a driven element for it or assist in debugging it. As with the improved 32-element Yagi listed in **table 3**, there is a possibility that the calculated dimensions won't work as expected. Other length versions are also possible.

Any of the presented designs can be used in the OSCAR, ATV, and fm portions of the band. For use in the satellite portion of the band, a 1/16-inch shortening of the elements is desirable, but not really necessary. For use on ATV, shorten all elements by 1/4 inch (6.4 mm). The Yagi will still be usable at 432 MHz, but will have about 0.2 dB lower forward gain. To use the Yagis in the fm portion of the band, shorten all elements by 7/16 inch. If the Yagis are to be mounted vertically polarized, they should be used in pairs with a boom support placed in the middle of the pair of Yagis (**fig. 18**). The driven element T match will have to be readjusted for best VSWR if the elements are shortened.

stacking considerations

Optimum stacking distances for the best array gain versus array temperature have been worked out for the antennas. The 24-element, 17-foot (5.3-meter) Yagi should be spaced 70 inches (1.78 meters) in the E plane (horizontal) and 66 inches (1.68 meters) in the H plane (vertical). The 32-element, 24-foot (7.3-meter) version 2 antenna works best with 81-inch (2.06-meter)

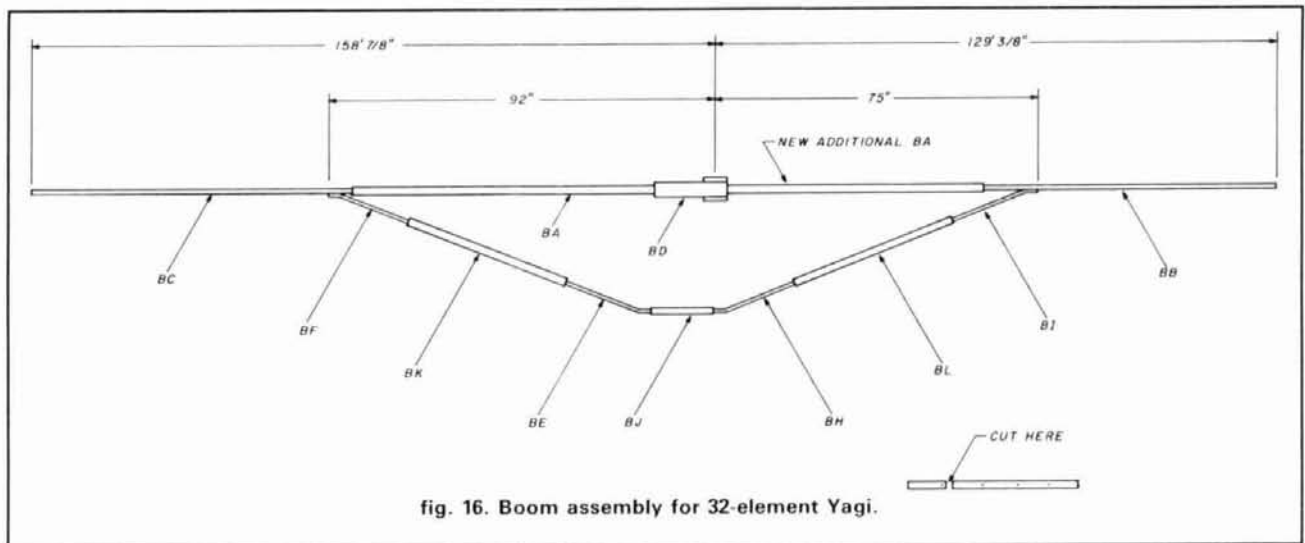


fig. 16. Boom assembly for 32-element Yagi.

**TE
SYSTEMS****RF POWER AMPLIFIERS**

- Lowest NF GaAs FET Preamp
- Finest Quality Military Construction
- Off-The-Shelf Dealer Delivery



For the past five years, Amateurs worldwide have sought quality amplifier products from TE Systems. Renowned for the incorporation of high quality, low-noise GaAs FET preamplifiers in RF power amplifiers, TE Systems offers our fine line of products through select national distributors.

All amplifiers are linear (all-mode), automatic T/R switching with adjustable delay and usable with drive levels as low as 1/2 Watt. We incorporate thermal shutdown protection and have remote control capability. All units are designed to ICAS ratings and meet FCC part 97 regulations. Approx. size is 2.8 x 5.8 x 10.5" and weight is 5 lbs.

Consult your local dealer or send directly for further product information.

SPECIFICATIONS

Model	Freq. MHz	Power		Preamp		DC +Vdc	Power A	RF Conn.
		Input	Output	NF-dB	Gain-dB			
0508G	50-54	1	170	.6	15	13.6	28	UHF
0510G	50-54	10	170	.6	15	13.6	25	UHF
NEW 1409G	144-148	3	160	.6	15	13.6	25	UHF
1410G	144-148	10	160	.6	15	13.6	25	UHF
1412G	144-148	30	160	.6	15	13.6	20	UHF
2210G	220-225	10	130	.7	12	13.6	21	UHF
2212G	220-225	30	130	.7	12	13.6	16	UHF
4410G	420-450	10	100	1.1	12	13.6	19	N
4412G	420-450	30	100	1.1	12	13.6	19	N

Models also available without GaAs FET preamp (delete G suffix on model #). All units cover full amateur band - specify 10 MHz bandwidth for 420-450 MHz amplifier.

Amplifier capabilities: 100-200 MHz, 225-400 MHz, 1-2 GHz, Military (28V), Commercial, etc. also available - consult factory.

**TE
SYSTEMS****TE SYSTEMS**

P.O. Box 25845
Los Angeles, CA 90025
(213) 478-0591

Gunnplexers & accessories 10 & 24 GHz



A. Microwave Associates 10 GHz Gunnplexer. Two of these transceivers can form the heart of a 10 GHz communication system for voice, mcw, video or data transmission, not to mention mountaintop DXing! MA87141-1 (pair of 10 mW transceivers) \$251.95. Higher power units (up to 200 mW) available. B. Microwave Associates 24 GHz Gunnplexer. Similar characteristics to 10 GHz unit. MA87820-4 (pair of 20 mW transceivers) \$739.20. C. This support module is designed for use with the MA87141 and MA87820 and provides all of the circuitry for a full duplex audio transceiver system. The board contains a low-noise, 30-MHz fm receiver, modulators for voice and mcw operation, Gunn diode regulator and varactor supply. Meter outputs are provided for monitoring received signal levels, discriminator output and varactor tuning voltage. RXMR30VD assembled and tested \$119.95. D. Complete, ready to use communication system for voice or mcw operation. Ideal for repeater linking. A power supply capable of delivering 13 volts dc at 250 mA (for a 10 mW version), microphone, and headphone and/or loudspeaker are the only additional items needed for operation. The Gunnplexer can be removed for remote mounting to a tower or 2 or 4 foot parabolic antenna. TR10GA (10 GHz, 10 mW) \$399.95. Higher power units available. TR24GA (24 GHz, 20 mW) \$639.95. Also available: horn, 2 and 4 foot parabolic antennas, Gunn, varactor and detector diodes, search and lock systems, oscillator modules, waveguide, flanges, etc. Call or write for additional information. Let ARR take you higher with quality 10 and 24 GHz equipment!

**Advanced
Receiver
Research**

Box 1242 • Burlington CT 06013 • 203 582-9409



159

THE CHAMP

BIRD MODEL 4304

**NO ELEMENTS
25-1000 MHZ
RF SAMPLING PORT**

AUTHORIZED **BIRD** DISTRIBUTOR

Webster

WEBSTER COMMUNICATIONS INC.
115 BELLARMINE
ROCHESTER, MI 48063
313-375-0420

CALL TOLL FREE
800-521-2333
800-482-3610

160

161

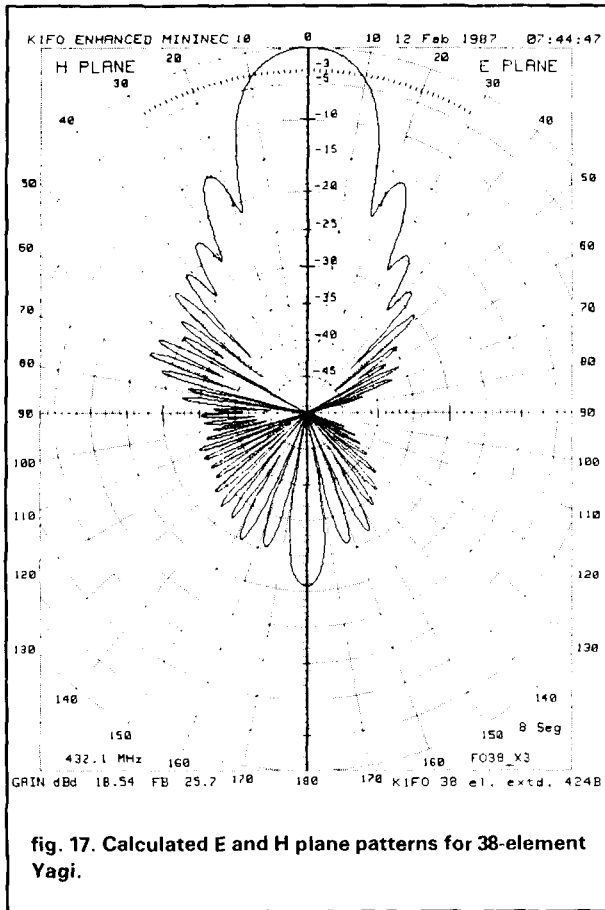


fig. 17. Calculated E and H plane patterns for 38-element Yagi.

E plane and 75-inch (1.91-meter) H plane spacing. These relatively wide spacings also confirm both the high gain and pattern cleanliness of the new Yagis. Calculated optimum spacings for the 32-element version 3 Yagis are 82-inch (2.08-meter) E plane by 77-inch (1.95-meter) H plane. For the 38-element Yagi, the calculated stacking distances are 88-inch (2.25-meter) E plane by 83-inch (2.11-meter) H plane. At these spacings, both E and H plane stacking gains will be close to 2.9 dB (negating phasing line losses and mechanical errors.)

when modification is worthwhile

Before you decide to tear down and modify your existing 424B's, you should carefully consider the results. A casual tropo operator using a single Yagi may be hard pressed to tell any forward gain difference between the stock and modified 24-element Yagi. The only noticeable differences will be in the pattern (signals off the main lobe will be weaker) and the better wet weather performance. Certainly most Amateurs aren't capable of detecting 0.5-dB gain variations. For an EME operator using eight or 16 Yagis, changing to even the modified 24-element version will result in significant improvement. On EME receive, it's expected that an eight-Yagi array will have about a 3-dB

Table 4. Dimensions for a 38-element Yagi (not tested).

Spacing	Length	Boom (inches)	
1.000,	13.6875	1	REF
5.250,	12.9375	1	DE
7.875,	12.7500	1	D1
11.563,	12.3750	1	D2
16.813,	12.3750	1	D3
23.563,	12.2500	1	D4
31.875,	12.0625	1	D5
42.125,	11.8750	1	D6
52.375,	11.7500	1	D7
62.625,	11.5625	1	D8
72.875,	11.4063	1 1/8	D9
83.125,	11.4063	1 1/8	D10
93.375,	11.4063	1 1/8	D11
103.625,	11.3438	1 1/8	D12
113.875,	11.2813	1 1/8	D13
124.125,	11.0938	1 1/8	D14
134.375,	11.0938	1 1/8	D15
144.625,	11.0625	1 1/4	D16
154.875,	11.0625	1 1/4	D17
165.125,	11.0625	1 1/4	D18
175.375,	11.0000	1 1/4	D19
185.625,	11.0000	1 1/4	D20
195.875,	11.0000	1 1/4	D21
206.125,	10.9375	1 1/4	D22
216.375,	10.9063	1 1/8	D23
226.625,	10.9063	1 1/8	D24
236.875,	10.8438	1 1/8	D25
247.125,	10.8438	1 1/8	D26
257.375,	10.8438	1 1/8	D27
267.625,	10.8438	1 1/8	D28
277.875,	10.7813	1 1/8	D29
288.125,	10.7500	1	D30
298.375,	10.7500	1	D31
308.625,	10.6875	1	D32
318.875,	10.6875	1	D33
329.125,	10.6875	1	D34
339.375,	10.6250	1	D35
349.625,	10.6250	1	D36

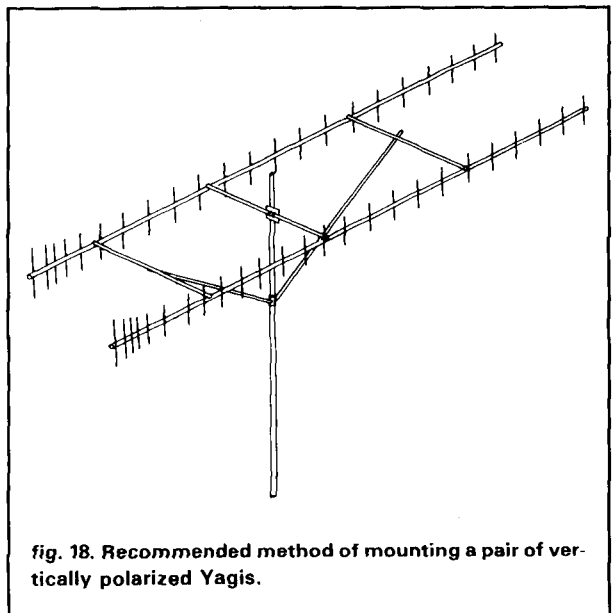


fig. 18. Recommended method of mounting a pair of vertically polarized Yagis.

CTM

The monthly magazine with a natural blending of two popular hobbies — Ham Radio and Computers

- ★ Articles on Ham Radio & Most Personal Computers
- ★ Hardware & Software Reviews
- ★ Various Computer Languages
- ★ Construction Articles
- ★ Much Much More

Your #1 Source for PACKET Info

"...received my moneys worth with just one issue..."

—J. Trenbick

"...always stop to read CTM, even though most other magazines I receive (and write for) only get cursory examination..."

—Fred Blechman, K6UGT

U.S.A.....\$18.00 for 1 year
 Mexico, Canada.....\$32.00
 Foreign.....\$43.00(land)-\$68.00(air)
 (U.S. funds only)
 Permanent (U.S Subscription).....\$150.00
 Sample Copy.....\$3.50



Circulation Manager
 1704 Sam Drive
 Birmingham, Alabama 35235
 Phone 205/854-0271

Name _____

Call Sign _____

Address _____

City _____ State _____

Zip _____ Phone _____

Date _____

Signature _____

162

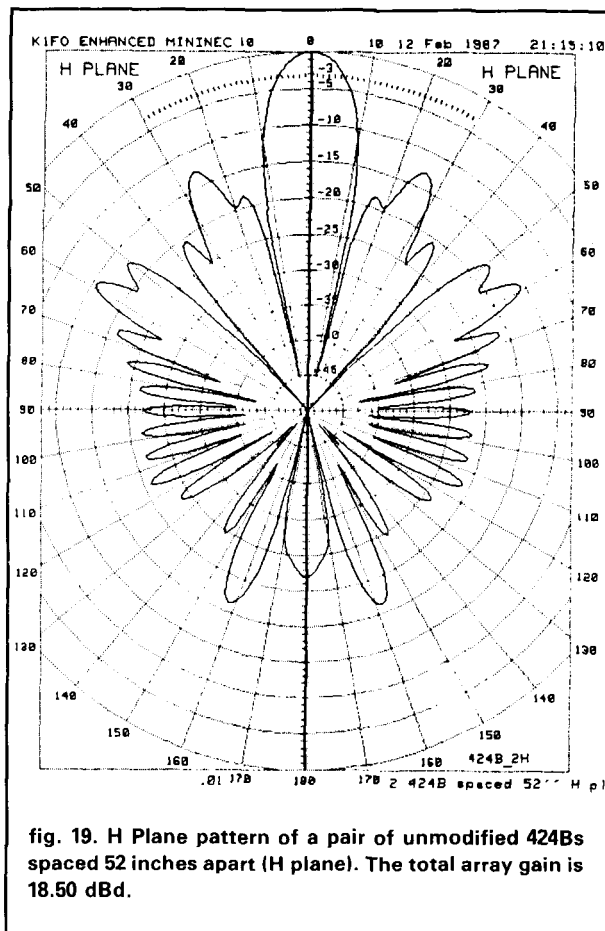


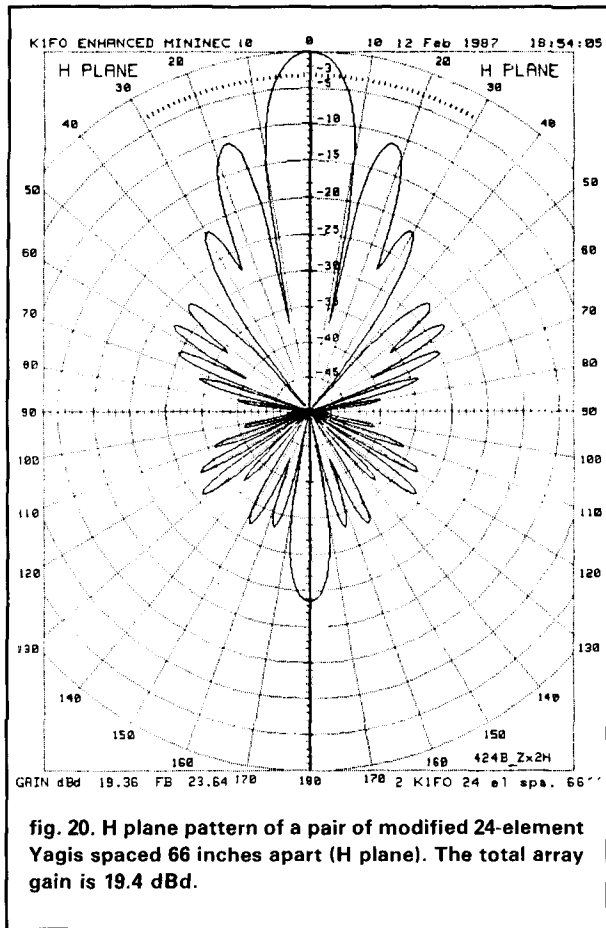
fig. 19. H Plane pattern of a pair of unmodified 424Bs spaced 52 inches apart (H plane). The total array gain is 18.50 dBd.

signal-to-noise improvement with the modified 24-element Yagis. This improvement is attributable to the following: +0.5 dB individual Yagi gain advantage; +1.0 dB higher array gain from wider optimum G/T spacings; +0.5 to 1.5 dB S/N due to lower array temperature from the cleaner array pattern.

On transmit, the gain advantage will be 1.5 dB because only the higher Yagi gain and wider spacings in the array contribute to the improvement. The signal-to-noise improvement is highly dependent upon the total receive system noise temperature. This is a combination of both the system noise figure and total phasing line loss. The actual S/N improvement could be from 0.5 dB to over 1.5 dB, depending upon the loss in the phasing lines and how low a noise figure the preamp has.

importance of clean patterns

In order to understand why a clean pattern on the individual Yagis is important, a computed H plane array pattern for two stock 424B's spaced at 52 inches is given in fig. 19. For comparison, the pattern for two of the modified 24-element Yagis, spaced 66 inches in the H plane, is given in fig. 20. Note that even at the significantly wider spacing, the array pattern of



the modified Yagis is significantly cleaner than the original. At 432 MHz there is approximately a 15-dB difference between cold sky noise and Earth noise. Total Earth noise pickup will be a sum total of all side lobes pointing into the Earth. This large difference in noise is why clean patterns are so important on 432-MHz EME arrays.

Although not an even comparison, it's informative to relate the experience of NC11 (ex-WA1RWU.) Frank had an array of 16 stock 424B's for 432-MHz EME. The array was rebuilt using 16 of the extended modified Yagis (32-element, 24-foot version). The results of the array rebuild are nothing short of spectacular. The receive improvement is far greater than the 1.8 dB extra gain the 24-foot (7.3-meter) Yagi has over the stock 17-foot (5.2-meter) antenna. Receive signals appear to be 5 to 6 dB above the old array, and echos are nearly 10 dB better. SSB speaker quality echos are frequently obtained with 100 watts output in the shack (approximately 80 watts at the array). Stations running four medium-sized Yagis such as the RIW-19s or F9FT-21s and 500 watts are readily workable.

A more even comparison is given by WA3FFC. Scott used an array of four stock 424B's on EME. Upon switching to the modified 24-element, same

boomlength Yagis, his Sun noise increased by 1.5 dB. Cold sky areas became much easier to find. Copy of his own echos was never obtained with the stock Yagis. With the modified 24-element versions, his echos are now regularly copied. Random EME QSOs are now possible with the modified array.

To further expound on how the state of four Yagi 432-MHz EME has evolved, consider the results of a recent portable EME expedition to Vermont by NC11. Frank took four of the 32-element Yagis to Vermont in the middle of June. Because of higher ionospheric absorption, greater Faraday shifts, increased tropo scattering, and longer daylight hours, the summer months are usually the poorest for 432-MHz EME. In spite of these obstacles, NC11 worked 22 stations on a single weekend. More impressive is that all QSOs were random — no prearranged schedules were used!

conclusion

With Yagi analysis software, the computer has succeeded in moving Amateurs from the dark ages of Yagi design to the point at which a well-performing Yagi can be readily made from materials at hand. The successful use of any antenna analysis program requires that the antenna designer have a thorough understanding of its capabilities and limitations.

In this project, the total design time — from the first correct running of the analysis program to completion of the initial Yagi — was over 10 months of continuous work. This time included physical tuning of the Yagis. Further improvements made to create the version 3, 24-element Yagi and version 2, 32-element Yagis were done during a year's intermittent work on the antennas. While this amount of design time may represent a high initial investment for a manufacturer of Yagi antennas, the design knowledge gained would most likely allow a similarly complex Yagi to be perfected in about one month. Continued enhancements of antenna design programs and more good Yagi designs will allow still further improvements in the quality of tomorrow's Yagis.

references

1. Günter Hoch, DL6WU, "More Gain with Yagi Antenna," *VHF Communications*, April, 1977, page 204.
2. Steve Powlishe, K1FO, "Stacking Yagis Is A Science," *ham radio*, May, 1985, page 18.
3. Stanley Jaffin, WB3BGU, "Applied Yagi Antenna Design," Part 6, *ham radio*, October, 1984, page 93.
4. Günter Hoch, DL6WU, "Yagi Antennas," *VHF Communications*, March, 1977, page 157.
5. Johann Bruinier, DL9KR, "Long Yagi Mark II," *The Lunar Letter*, December, 1983, page 6.
6. Günter Hoch, DL6WU, "Yagi Antennas," *VHF Communications*, March, 1977, page 162.
7. Joe Reiser, W1JR, "VHF/UHF World: A High-gain 70-cm Yagi," *ham radio*, December, 1986, page 75.

ham radio

ASTRON POWER SUPPLIES

• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

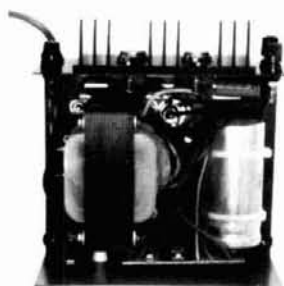
RS and VS SERIES

SPECIAL FEATURES

- SOLID STATE ELECTRONICALLY REGULATED
- FOLD-BACK CURRENT LIMITING Protects Power Supply from excessive current & continuous shorted output.
- CROWBAR OVER VOLTAGE PROTECTION on all Models except RS-4A.
- MAINTAIN REGULATION & LOW RIPPLE at low line input Voltage.
- HEAVY DUTY HEAT SINK • CHASSIS MOUNT FUSE
- THREE CONDUCTOR POWER CORD
- ONE YEAR WARRANTY • MADE IN U.S.A.

PERFORMANCE SPECIFICATIONS

- INPUT VOLTAGE: 105 - 125 VAC
- OUTPUT VOLTAGE: 13.8 VDC \pm 0.05 volts (Internally Adjustable: 11-15 VDC)
- RIPPLE: Less than 5mv peak to peak (full load & low line)



INSIDE VIEW - RS-12A



MODEL RS-50A



MODEL RS-50M



MODEL VS-50M

RM-A Series



MODEL RM-35A

19" X 5 1/4" RACK MOUNT POWER SUPPLIES

Model	Continuous Duty (AMPS)	ICS* (AMPS)	Size (IN) H X W X D	Shipping Wt. (lbs.)
RM-35A	25	35	5 1/4 x 19 x 12 1/2	38
RM-50A	37	50	5 1/4 x 19 x 12 1/2	50
• Separate Volt and Amp Meters RM-35M	25	35	5 1/4 x 19 x 12 1/2	38
RM-50M	37	50	5 1/4 x 19 x 12 1/2	50

RS-A SERIES



MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-4A	3	4	3 1/4 x 6 1/2 x 9	5
RS-7A	5	7	3 1/4 x 6 1/2 x 9	9
RS-7B	5	7	4 x 7 1/2 x 10 3/4	10
RS-10A	7.5	10	4 x 7 1/2 x 10 3/4	11
RS-12A	9	12	4 1/2 x 8 x 9	13
RS-20A	16	20	5 x 9 x 10 1/2	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13 3/4 x 11	46

RS-M SERIES



MODEL RS-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
• Switchable volt and Amp meter RS-12M	9	12	4 1/2 x 8 x 9	13
• Separate Volt and Amp Meters RS-20M	16	20	5 x 9 x 10 1/2	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13 3/4 x 11	46

VS-M SERIES



MODEL VS-20M

- Separate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @ 13.8VDC @ 10VDC @ 5VDC	ICS* (Amps) @ 13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16 9 4	20	5 x 9 x 10 1/2	20
VS-35M	25 15 7	35	5 x 11 x 11	29
VS-50M	37 22 10	50	6 x 13 3/4 x 11	46

RS-S SERIES



MODEL RS-12S

- Built in speaker

MODEL	Continuous Duty (Amps)	ICS* Amps	Size (IN) H x W x D	Shipping Wt (lbs)
RS-7S	5	7	4 x 7 1/2 x 10 3/4	10
RS-10S	7.5	10	4 x 7 1/2 x 10 3/4	12
RS-10L (For LTR)	7.5	10	4 x 9 x 13	13
RS-12S	9	12	4 1/2 x 8 x 9	13
RS-20S	16	20	5 x 9 x 10 1/2	18

build a 1-1000 MHz amplifier using MAR-4 MMICs

Simple device,
many applications

During the last few years the availability of surplus test equipment has made fairly sophisticated rf measurements possible for hams on small budgets. Many own rf signal generators with accurate output attenuators that provide precise signal levels. Using the new microwave IC amplifiers, it's easy to build a broadband utility amplifier to serve as a handy test aid for signal generators.¹

Broadband amplifiers are widely used — and sold in many different models — to increase the accuracy and range of rf measurements. Typical uses include the following:

- Boosting signal generator output for aligning a "numb" receiver or a badly misaligned bandpass filter.
- Increasing isolation between signal generators in multi-generator setups (as in two-tone third-order intermodulation tests).
- Regaining lost power (when attenuators are used at the test interface to ensure a proper 50-ohm impedance match).
- Increasing measurement range (to determine insertion loss of filters).

Parts information and construction details are given for making a broadband utility amplifier that covers hf through UHF with 13 dB gain and +10 dBm output. Most parts are readily available, and construction takes only a few hours.

design considerations

The amplifier IC was selected on the basis of gain and output power required. I needed at least +10 dBm output because this is the maximum power indicated by my thermistor-mount power meter. Because the signal generator output sometimes drops to 0 dBm, 10-dB gain was required. Designed around the Mini-

Circuits Lab MAR-4, the amplifier and power supply are shown in **fig. 1**.²

Specifications of the MAR-4s are shown in **table 1**. Since the amplifiers have 50-ohm input/output impedances and are guaranteed to be stable regardless of load, the only design effort is selecting a power supply dropping resistor. I decided to sacrifice gain for simplicity and not use a series rf choke, making the resistance as large as possible. The power supply current is a substantial 50 mA, so power dissipation is a consideration. The 180-ohm resistance was selected as a maximum convenient value within the restric-

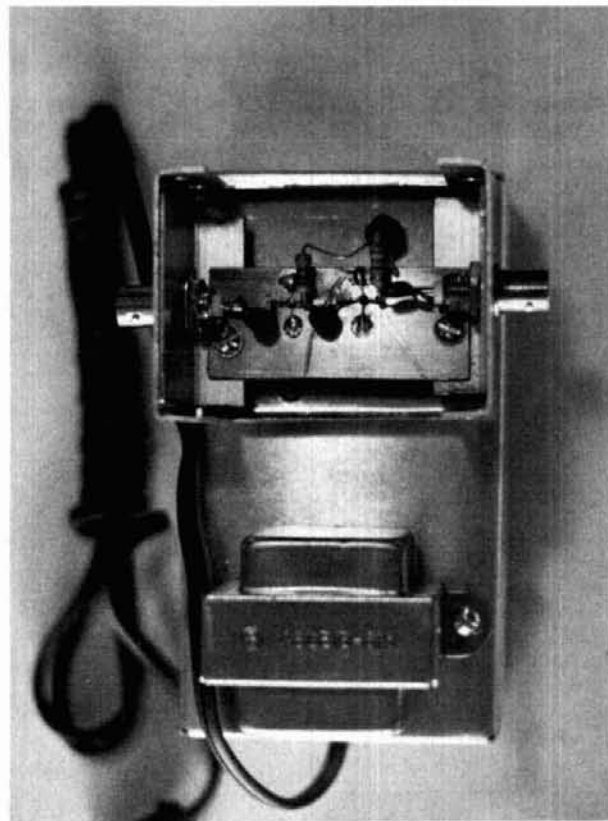


Photo A. Self contained MMIC amplifier and power supply, with mini-box cover removed.

By Cliff Klinert, WB6BIH,, 1126 Division Street,
National City, California 92050

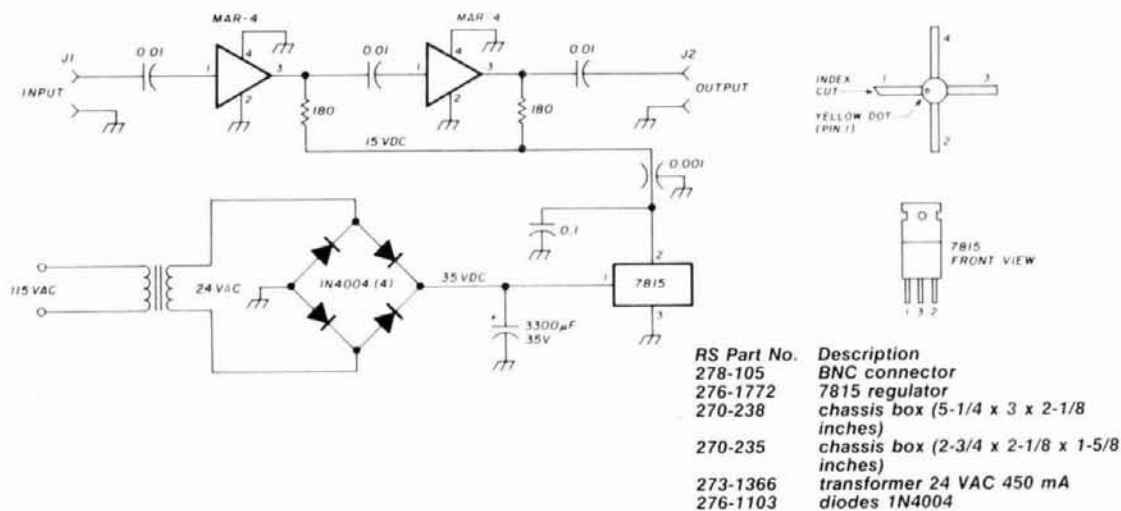


fig. 1. Complete broadband amplifier including power supply. The 0.01 and 0.1- μ F capacitors are disc ceramic and the resistors 1/2-watt carbon composition.

Table 1. Specifications of Mini-Circuits Labs MAR-4 MMICs.

frequency	dc to 1000 MHz
gain	7 dB (minimum)
flatness	± 0.5 dB
output (+1 dB compression)	+11 dBm
input (no damage)	+15 dBm (maximum)
noise figure	7 dB typical
VSWR (in)	1.9:1
VSWR (out)	2.0:1
dc power	5 volts at 50 mA
price	\$1.90 (minimum quantity 25)

tion of 1/2-watt dissipation. A 7815 regulator provides a convenient 15-volt source for the 10-volt drop.

My surplus thermistor-mount power meter goes down to almost -30 dBm. Notice the use of the word "almost" here; it indicates the difficulty in making measurements below -30 dBm because of thermal drift. Increasing the top end from 0 dBm to +10 dBm by adding this amplifier provides a 10-dB increase in total range, which represents significant improvement.

building the amplifier

The main objective of this project was to use fast, easy construction techniques with readily available parts. The components were soldered together on an unetched printed circuit board, with component leads cut as short as possible. Small 0.01- μ F disc ceramic capacitors were used for coupling. **Photo A** shows the amplifier mounted in a small chassis box, which is mounted on a larger box housing a power supply.

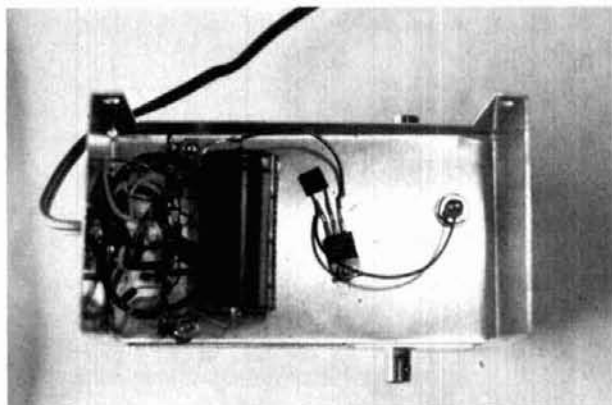


Photo B. Bottom view of the power supply components and wiring. The large tubular item in the middle is the 3300- μ F capacitor.

A circuit board is used as a ground plane and is fastened with small brackets. This type of construction avoids etched stripline circuit boards and chip components typical of microwave construction.³ **Photo B** is an underside view of the power supply components and wiring. The large cylindrical item in the middle is the 3300- μ F capacitor. Be careful when soldering the MMIC leads; they break easily.

Because this amplifier is a test accessory, it will be handled frequently, and you may find that screws and other parts loosen easily. Make sure that the connectors used for J1 and J2 are fastened securely; adding a drop of paint or glue to the mounting hardware will help prevent loosening. The feedthrough capacitor shown in **fig. 1** was a junkbox item which conveniently

THE BIGGEST IMPROVEMENT IN YOUR SHACK

A PAIR FOR PACKET BOOMER 215WB AND 124WB

For best gain, to work distant repeaters, FM Simplex, Sideband or Packet, **215WB** is the choice of more active hams. For gain and directivity in a limited space, **124WB**, with wideband technology, is the newest Boomer.

Both models include time proven computer designed features with T match driven elements for lowest SWR over the entire two meter band. The strong construction is heavy wall tubing, solid aluminum rod elements plus all stainless steel hardware, and precision machine formed components. You will also like the quick easy assembly of these antennas.

Make Boomer your choice today for more 2 meter enjoyment.

SPECIFICATIONS

124WB 215WB

Frequency MHz	144-148	144-148
Gain	Excellent	
F/B Ratio dB	Excellent	
Boom length ft	4	15
Beam width Deg.		
E Plane	2 x 30	2 x 17
H Plane	2 x 42	2 x 18
Weight lbs	3	8

SHOULD BE ON THE TOWER

ANT FACTS

PREINSTALLATION SWR CHECK

Checking SWR before installation is easy. Find an open area and stand your antenna with the boom vertical, reflector end down. Support the antenna with the reflector a few feet off the ground. The antenna can be held in place with light rope. **STAY AWAY FROM POWER LINES.**

This process reduces the ground effects. You can make tentative SWR checks here. The SWR may be slightly different when the antenna is moved to its permanent position. It is likely that the variation will not be significant. When you have completed the SWR check, make sure that all fasteners and connections have been properly tightened.



Cushcraft ANTENNAS

P.O. BOX 4680, 48 Perimeter Road, Manchester, NH 03108 USA • Telephone: 603-627-7877
Telex: 4949472 Cushsig Man

K.V.G. CRYSTAL PRODUCTS



9 MHz CRYSTAL FILTERS

MODEL	Application	Bandwidth	Poles	Price
XF-9A	SSB	2.4 kHz	5	\$61.00
XF-9B	SSB	2.4 kHz	8	83.00
XF-9B-01	LSB	2.4 kHz	8	110.00
XF-9B-02	USB	2.4 kHz	8	110.00
XF-9B-10	SSB	2.4 kHz	10	145.00
XF-9C	AM	3.75 kHz	8	89.00
XF-9D	AM	5.0 kHz	8	89.00
XF-9E	FM	12.0 kHz	8	89.00
XF-9M	CW	500 Hz	4	62.00
XF-9NB	CW	500 Hz	8	127.00
XF-9P	CW	250 Hz	8	175.00
XF-910	IF noise	15 kHz	2	21.00

10.7 MHz CRYSTAL FILTERS

WRITE FOR FULL DETAILS OF CRYSTALS AND FILTERS
Export inquiries invited. Shipping: \$3.75

MICROWAVE MODULES EQUIPMENTS

Use your existing HF or 2M rig on other VHF or UHF bands.

RECEIVE CONVERTERS

MMk 1691-137	270.00
MMk 1296-144G	190.00
MMc 439-ATV	99.00
MMc 432-28(s)	70.00
MMc 144-28(HP)	73.00
MMc 144-28	60.00

LINEAR TRANSVERTERS

MML 1296-144G	370.00
MMx 1268-144	290.00
MML 432-28(S)	280.00
MML 144-28(R)	400.00
MML 144-28	200.00
MML 435-28(S)	300.00

LINEAR POWER AMPLIFIERS

2M	70cm	
MML 144-30-LS	MML 432-30-L	245.00
MML 144-50-S	MML 432-50	220.00
MML 144-100-S	MML 432-100	450.00
MML 144-100-LS		
MML 144-200-S		

ANTENNAS

2M: 10XY-2M	\$80.00	LOOP YAGIS	
70cm: 70/MBM28	\$50.00	1268-LY	55.00
70/MBM48	70.00	1296-LY	55.00
70/MBM88	115.00	1691-LY	65.00
DY20-900 MHz	80.00	order loop yagi connector extra	



Send 66¢ (3 stamps) for full details of all our VHF & UHF equipments and KVG crystal products.

Shipping: FOB Concord, Mass.



(617) 263-2145
SPECTRUM INTERNATIONAL, INC.
Post Office Box 1084
Concord, MA 01742, U.S.A.

Table 2. Measured test results.

frequency (MHz)	amplifier input power (dBm)
1	+1.0
3	-2.0
5	-2.6
10	-3.0
25	-3.0
50	-3.0
75	-3.0
100	-3.0
150	-2.9
200	-3.0
300	-2.8
400	-2.0
450	-1.8

helps secure the small box to the larger one. It could be replaced with a disc ceramic.

Though a fairly well-stocked junkbox should include most parts, I've provided Radio Shack part numbers to simplify component acquisition (see fig. 1). To obtain the MMIC's, contact Mini-Circuits² and ask for the Mini-Circuits distributor nearest you. The distributor may or may not be able to fill a small order. Because there's no distributor nearby, I bought the DAK-1 Designer's Amplifier Kit of 30 assorted amplifiers for \$49.99 (plus shipping) directly from Mini-Circuits; this price is slightly less than the quantity price of the individual ICs. The kit solves the problem of providing prototype samples for design engineers; perhaps some of the mail-order suppliers that cater to hobbyists will soon stock these new ICs.

measured results

The amplifier was connected between a signal generator and thermistor power meter using short RG-58 BNC cables to test gain and frequency response. The data shown in table 2 was measured with the amplifier output power set to +10 dBm at each frequency.

The low frequency gain starts to roll off at 1 MHz because of the three 0.01- μ F coupling capacitors. The small reduction in gain at 450 MHz may have been caused by the type of construction used and losses in the cables. I was delighted to find the amplifier stable and free from oscillation, with nearly constant gain over the frequency range of interest.

references

1. Joe Reisert, W1JR, "VHF/UHF World," *ham radio*, November 1986, page 91.
2. *RF/IF Signal Processing Guide 1986-87*, free catalog available from Mini-Circuits, P.O. Box 166, Brooklyn, New York 11235.
3. Jerry Hinshaw, N6JH, "Monolithic RF Amplifiers," *ham radio*, March 1986, page 23.

ham radio

BASEBALL CAP

How about an attractive **BASEBALL** style cap that has name and call on it. It gives a jaunty air when worn at Hamfests and it is a great help for friends who have never met to spot names and calls for easy recognition. Great for birthdays, anniversaries, special days, whatever occasion. Hats come in the following colors: **GOLD, BLUE, RED, KELLY GREEN.**

Please send call and name (maximum 6 letters per line).

UFBC-81 \$6.00 **WA2SRF**



ham radio

I.D. BADGES

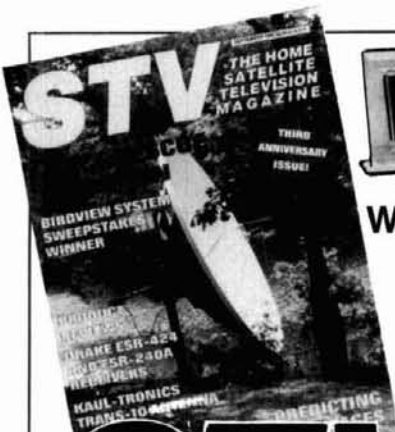
No ham should be without an I.D. badge. It's just the thing for club meetings, conventions, and get-togethers, and you have a wide choice of colors. Have your name and call engraved in either standard or script type on one of these plastic laminated I.D. badges. Available in the following color combinations (badge/lettering): white/red, wood-grain/white, blue/white, white/black, yellow/blue, red/white, green/white, metallic gold/black, metallic silver/black.

UID Engraved I.D. Badge \$2.50

BOOKSTORE

Greenville, NH
03048

Please add \$3.50 for shipping and handling



RECEIVE THIS LCD CALENDAR/CLOCK FREE WITH YOUR SUBSCRIPTION

WHAT'S REALLY HAPPENING IN HOME SATELLITE TV?

STV THE HOME SATELLITE TELEVISION MAGAZINE™

A monthly of 100-plus pages—has everything you need to know about where to find equipment, how to install it, system performance, legal viewpoints, and industry insights! With your subscription to STV® you will receive a FREE LCD Calendar/Clock.

- Only \$19.95 per year (12 monthly issues)
- \$1.00 for sample copy

IF YOU HAVE A SATELLITE SYSTEM, THEN YOU REALLY NEED ...



OnSat

The best in satellite programming! Featuring: ★All Scheduled Channels ★Weekly Updated Listings ★Magazine Format ★Complete Movie Listing ★All Sports Specials ★Prime Time Highlights ★Specials Listing and ★Programming Updates!

- Only \$45.00 per year (52 weekly issues)
- 2 Years \$79.00 (104 weekly issues)
- \$1.00 for sample copy

Visa® and MasterCard® accepted (subscription orders only). All prices in US funds. Write for foreign rates.

Send this ad along with your order to:

STV®/OnSat®

P.O. Box 2384—Dept. HR • Shelby, NC 28151-2384
SUBSCRIPTION CALLS ONLY
TOLL FREE 1-800-438-2020

SEE HOW \$24.95 PROTECTS \$1,000's OF YOUR FAVORITE GEAR!

- ☐ **Easy to Use** - Now security is as simple as adhering the metal pad to the top, bottom or side of your equipment. The 3M® adhesive gives you up to 1,000# of holding power. No holes to violate warranties.
- ☐ **Tough Protection** - The strength of a 5/16" vinyl clad steel cable measuring 1 1/2 feet, and a padlock eye that accommodates the largest locks.
- ☐ **Satisfaction Guaranteed** - If you aren't sleeping better at night we'll refund your money.



Super Pad™ Kit:
 2 cabled pads, 4 feet for bottom mounting, Master® padlock (choose textured black or beige)
\$49.95

Single Super Pad with 4 feet **\$24.95**
5' Extension Cable **\$14.95**

BYTE BROTHERS
 3602 Lake Washington Blvd. N.
 Renton, WA 98056
(206) 271-9567

Patent pending. Add \$2.00 per order for postage and handling. VISA, MasterCard, and phone orders accepted. All units made in the U.S.A. 3M is a trademark of the 3M Company

✓ 167

AMATEUR TELEVISION



KPA5 1 WATT 70 CM ATV TRANSMITTER BOARD

- **APPLICATIONS:** Cordless portable TV camera for races & other public service events, remote VCR, etc. Remote control of R/C airplanes or robots. Show home video tapes, computer programs, repeat SSTV to local ATVers. DX depends on antennas and terrain typ. 1 to 40 miles.
- **FULL COLOR VIDEO & SOUND** on one small 3.25x4" board.
- **RUNS ON EXTERNAL 13.8 VDC** at 300 ma supply or battery.
- **TUNED WITH ONE CRYSTAL** on 426.25, 434.0, or 439.25 mHz.
- **2 AUDIO INPUTS** for a low Z dynamic and line level audio input found in most portable color cameras, VCRs, or home computers.
- **APPLICATION NOTES** & schematic supplied for typical external connections, packaging, and system operation.
- **PRICE ONLY \$159** delivered via UPS surface in the USA. Technician class amateur license or higher required for purchase and operation.

WHAT IS REQUIRED FOR A COMPLETE OPERATING SYSTEM? A TV set with a TVC-2 or TVC-4 420-450 mHz to channel 3 downconverter, 70 cm antenna, and coax cable to receive. Package up the KPA5, add 12 to 14 vdc, antenna, and any TV camera, VCR, or computer with a composite video output. Simple, eh?

CALL OR WRITE FOR OUR COMPLETE CATALOG & more info on atv downconverters, antennas, cameras, etc., or who is on in your area.

TERMS: Visa, Mastercard, or cash only UPS COD by telephone or mail. Telephone orders & postal MO usually shipped within 2 days, all other checks must clear before shipment. Transmitting equipment sold only to licensed amateurs verified in 1984 Callbook. Calif. include sales tax.

(818) 447-4565 m-f 8am-6pm pst.

P.C. ELECTRONICS
 Tom W60RG Maryann WB6YSS

 
 2522 Paxson Lane
 Arcadia CA 91006

✓ 166

✓ 240

VHF/UHF WORLD

Joe Feiser
W1JK

operating a VHF/UHF/microwave station

Just as in hf operation, good operating practices make VHF, UHF, and microwave operation a pleasure not only for you but for other Amateurs as well. These practices enhance your chances of experiencing some of the more exotic propagation modes and operating techniques. Since some Amateurs may be hesitant about entering the VHF territory, I'll devote this month's column to those practices, in hope that the information presented will ease their transition to the world above 10 meters and help increase the enjoyment for those already operating there.

frequency plans

Each Amateur band above 50 MHz covers a wider frequency spectrum than all the present hf bands combined! Furthermore, on VHF and above there are more types of transmission emissions than you'll find on the typical hf bands: CW, SSB, packet, a-m, RTTY, and slow-scan ATV. While the FCC has placed limits on types of emissions within each of these bands, the only real restrictions above 50 MHz are between 50.0 and 50.1 and 144.0 to 144.1 MHz, which are allocated exclusively for CW operation. Reference 1 lists all the Amateur frequency allocations above 50 MHz; reference 2 shows the microwave/millimeter-wave bands after the FCC

update of March 1, 1986. Reference 3 lists the modes permitted on all Amateur bands.

After World War II, North American VHFers established gentlemen's agreements or frequency (usage) plans. This worked fine while the VHF bands weren't too populated, but started to break down in the 1970s as activity increased and the number of different emissions and repeaters in operation increased. Let's face it; weak-signal operation using CW or SSB is virtually impossible alongside an fm repeater radiating reasonable ERP (effective radiated power) from a mountaintop location!

In 1978, therefore, North American "band plans" were drawn up by the ARRL VHF/UHF Advisory Committee (VUAC) in accordance with the wishes of many users from various interest groups. I was the chairman of that committee when these plans were formulated. It wasn't an easy job to satisfy everyone. All inputs had to be integrated so that the overall band plan would be fair and equitable for the majority rather than the minority. At the same time, band plans had to allow some room for specialized communications such as EME and OSCAR. Finally, they had to have some flexibility for future operating trends. Believe me, there were some tense moments.

The first band plans that emerged were for the 2-meter, 135-cm (220-225 MHz), 70-cm (420-450 MHz), and

23-cm (then 1215-1300, now 1240-1300 MHz) bands. Still more or less as originally formulated, these band plans also established the primary "calling frequencies" (to be discussed shortly) that are now in use. Several years later band plans were formulated for the 6-meter and 33-cm (902-928 MHz) bands. These band plans are fairly comprehensive and also list recommended fm repeater pairs.⁴

Most important for weak-signal work is the recommended calling frequency on each band. When the Amateur population density is low, there's a need for a specific frequency to monitor for unexpected openings or to serve as a place for meeting new friends or greeting new arrivals on the band. Tuning or scanning the whole band isn't only time consuming; it can often result in missing stations who call a quick CQ, hear no takers, and move on.

Furthermore, with the lower power and narrower antenna beamwidth that are typical of the VHF and above frequencies, it's sometimes difficult to hear someone, even on the calling frequency. The modern antennas are sporting pretty clean radiation patterns, so don't forget to change your antenna beam heading occasionally. I'm sure that those who use the present calling frequencies will agree that this is a much more productive approach to locating other stations and band openings than the methods used in "the good old days."

Table 1. Recommended North American calling frequencies.

Band	Calling Frequency	Notes
6 m	50.110	DX National
	50.200	
2 m	144.100	CW SSB
	144.200	
135 cm	220.100	
70 cm	432.100	
33 cm	903.100	
23 cm	1296.100	
13 cm	2304.100	

Table 1 shows the recommended calling frequencies where applicable. A few suggestions are in order. Once contact is established on the calling frequency, it's common courtesy to QSY up or down at least 10 kHz in order not to QRM the calling frequency and to make it available for others to use. Always remember that many people may be monitoring or want to use the calling frequency whether the band is open or not, so don't tie it up needlessly!

However, if no one transmits, how do you know the band is open? *Never use the calling frequency as a tune-up frequency.* Find another frequency where you won't cause interference or blow the head off somebody who's monitoring the calling frequency. However, put out a call or CQ occasionally. You may be pleasantly surprised by a response.

HF versus VHF Dxing

If there's one major difference between operating on the hf and VHF bands, it's most easily summed up in the term "DX." Generally speaking, the communication distances on the VHF bands aren't those that many of us work on hf. As a result, VHFers have a different notion as to what constitutes DX. Working Europe, Africa, or Asia on 20 meters may be routine for an hf DXer; but for a VHFer, working over 250 miles on 2 meters may involve a greater degree of difficulty.

Consequently, VHF and UHFers

need a different yardstick by which their accomplishments can be measured. For many years, while DXers on hf were busy contacting new DXCC countries, VHF and UHFers in North America were chasing new ARRL sections, states, or counties. Probably the most popular award was the WAS (Worked All States). However, without EME, a WAS award is virtually impossible on 2 meters and above. What do you do when you've worked all states that are available using all the normal propagation modes?

European VHFers have an advantage over North Americans: in Europe, an area slightly smaller than the size of the continental United States, there are more DXCC countries than there are states in the United States. However, Europeans still weren't satisfied and in the early 1960s devised a system called "QTH Locator" or "locator" for short.

Europe was essentially subdivided into latitude/longitude blocks, each 2 degrees in longitude by 1 degree in latitude. At mid-latitudes this locator system yielded a square measuring about 70 by 60 miles. Each square was given a two-letter designation between AA and ZZ. For more accuracy, each square was further subdivided to pinpoint the location down to a few miles. A typical European locator, then, had five characters such as FR30c for SK6AB or TH69c for UW6MA. Unfortunately, the European locator system couldn't be used elsewhere without ambiguities or duplication. Hence,

when out-of-continent DX modes such as EME became popular, a different locator scheme was needed.

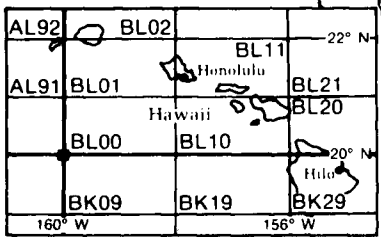
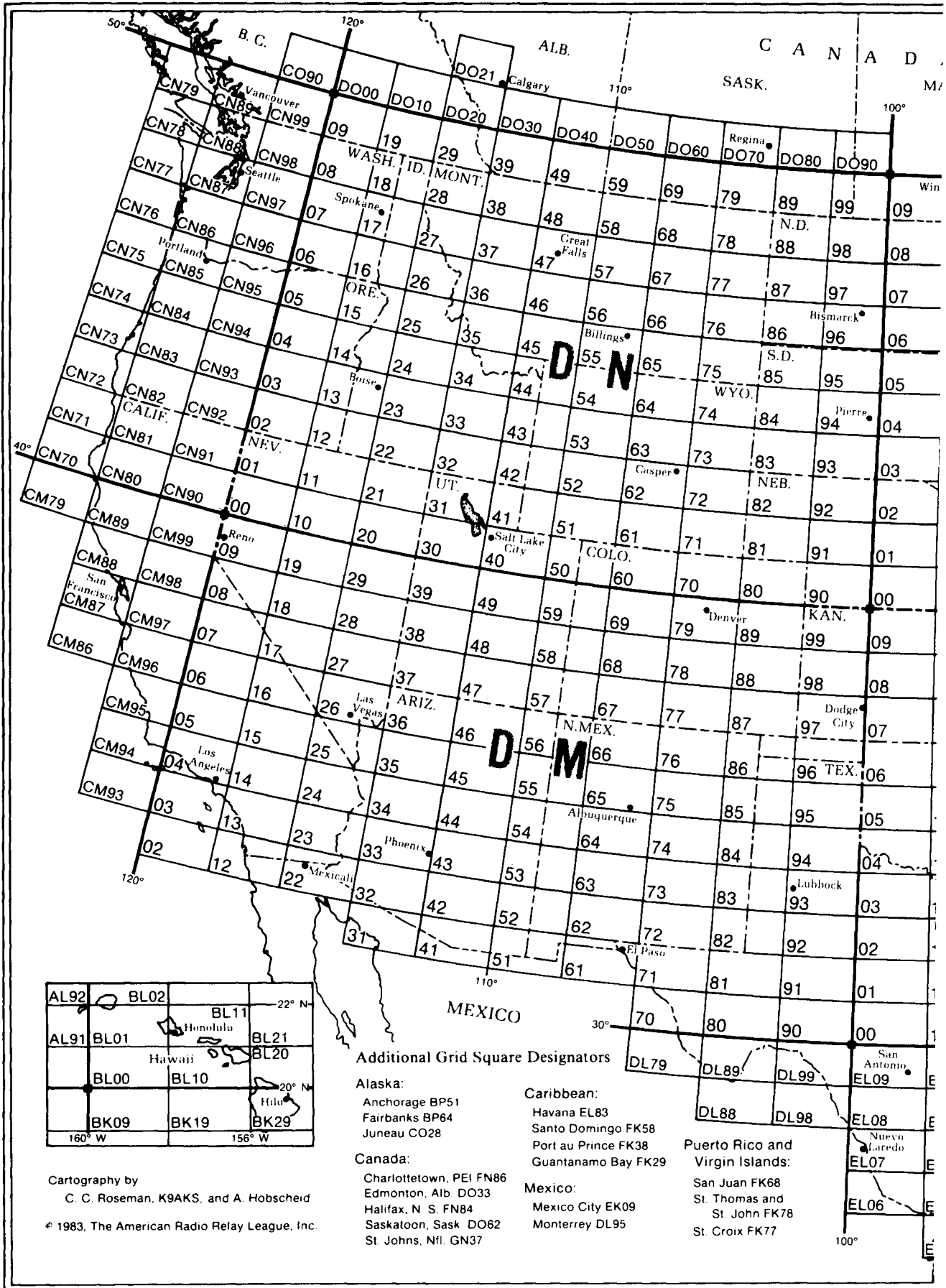
The search for a worldwide locator system was long and arduous. Several systems were proposed. The ARRL finally adopted the "Maidenhead" locator system, a scheme named after the town in England where a committee finally agreed upon a worldwide system without ambiguities.⁵

This locator system divides the Earth into 324 different "fields," each 20 degrees in longitude by 10 degrees in latitude. The system reference begins at the South Pole on the 180th parallel. Each field is given a two-letter designation between AA and RR. Each field is further subdivided into 100 different sections, numbered 00 thru 99, usually referred to in North American as "grid squares."

Figure 1 shows the ARRL grid square map covering the continental United States and lower Canada. If you live in this region and know your latitude and longitude (a must for all VHFers) you can quickly determine your four-character grid square using the map in **fig. 1**. Maps similar to this one are now widely available from various VHF equipment suppliers. If you don't know your grid square, just ask local VHFers. They'll be glad to assist.

However, note that a four-character locator has an accuracy of only approximately 50 to 75 miles. If greater accuracy — such as that offered by the European five-character scheme — is necessary, more information is required. In the Maidenhead system, two additional characters are used. Information on how to determine your six-character grid square may be found in tables listed in reference 5.

For example, my home is located at North latitude 42 degrees, 34 minutes, 58 seconds, and West longitude 71 degrees, 22 minutes, 35 seconds. Therefore the six-character grid square is FN42HN. When even greater accuracy is needed — on the microwave frequencies, for example — an eight-character system can be used by adding two more characters to pinpoint the exact location.



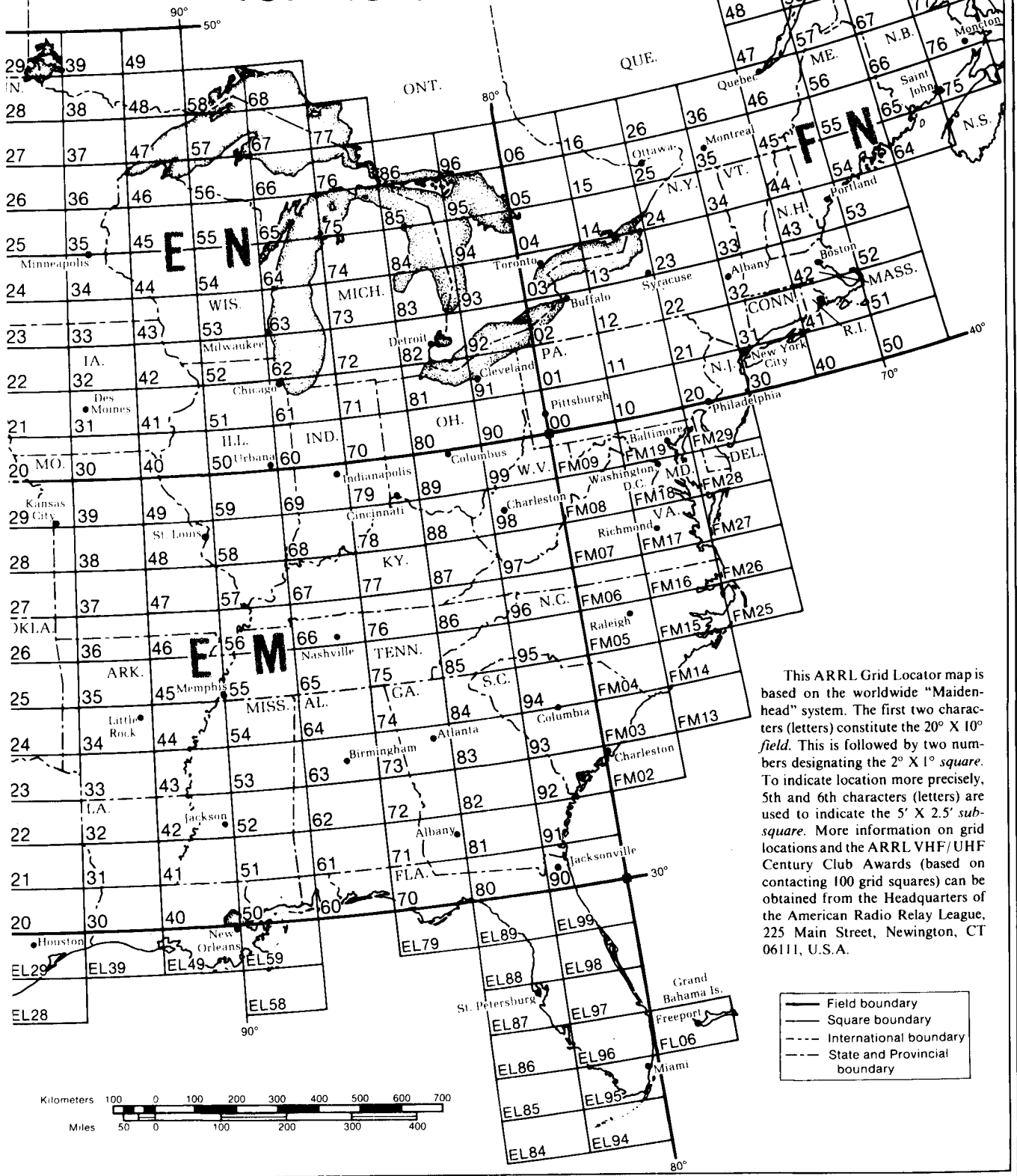
Additional Grid Square Designators

- Alaska:**
 Anchorage BP51
 Fairbanks BP64
 Juneau CO28
- Canada:**
 Charlottetown, PEI FN86
 Edmonton, Alb DO33
 Halifax, N. S. FN84
 Saskatoon, Sask DO62
 St. Johns, Nfld. GN37
- Caribbean:**
 Havana EL83
 Santo Domingo FK58
 Port au Prince FK38
 Guantanamo Bay FK29
- Mexico:**
 Mexico City EK09
 Monterrey DL95
- Puerto Rico and Virgin Islands:**
 San Juan FK68
 St. Thomas and St. John FK78
 St. Croix FK77

Cartography by
 C. C. Roseman, K9AKS, and A. Hobscheid
 © 1983, The American Radio Relay League, Inc.



ARRL Grid Locator for North America



This ARRL Grid Locator map is based on the worldwide "Maidenhead" system. The first two characters (letters) constitute the 20° X 10° field. This is followed by two numbers designating the 2° X 1° square. To indicate location more precisely, 5th and 6th characters (letters) are used to indicate the 5' X 2.5' sub-square. More information on grid locations and the ARRL VHF/UHF Century Club Awards (based on contacting 100 grid squares) can be obtained from the Headquarters of the American Radio Relay League, 225 Main Street, Newington, CT 06111, U.S.A.

- Field boundary
- Square boundary
- - - International boundary
- - - State and Provincial boundary

fig. 1. This is a copy of the official ARRL VUCC grid locator map for North America. An 18 x 12-inch copy is available from the ARRL for \$1.00.

Measure Up With Coaxial Dynamics Model 83500 Digital Wattmeter

The "Generation Gap" is filled with the "new" EXPEDITOR, the microprocessor based R.F. AnaDigit System. The EXPEDITOR power computer...you make the demands, it fills the requirements.

- Programmable forward AND reflected power ranges.
- Can be used with the elements you now have.
- Compatible with all Coaxial Dynamics line sizes and power ranges.
- 18 scales from 100 mW to 50 kW.

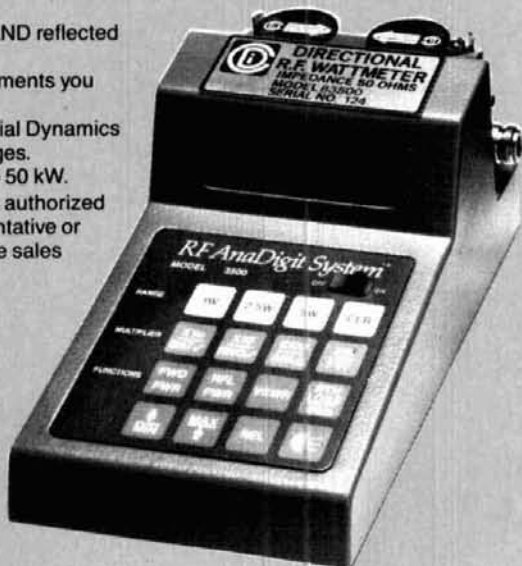
Contact us for your nearest authorized Coaxial Dynamics representative or distributor in our world-wide sales network.



**COAXIAL
DYNAMICS, INC.**

15210 Industrial Parkway
Cleveland, Ohio 44135
216-267-2233 1-800-COAXIAL
Telex: 98-0630

Service and Dependability...A Part of Every Product



✓ 192

✓ 169

NEMAL ELECTRONICS

HARDLINE — 50 OHM

Nemal No.	Description	100 Ft.	Per Ft.
FXA12	1/2" Aluminum Black Jacket	89	
FLC12	1/2" Corr. Copper Blk. Jkt.	159	
FLC78	7/8" Corr. Copper	392	
NM12AL	N Conn., 1/2" Alum. (Male or Female)	22.00	
NM12CF	N Conn., 1/2" Copper (Male or Female)	22.00	
NM78CC	N Conn., 7/8" Copper (Male or Female)	54.00	

COAXIAL CABLES

Nemal No.	Description	100 Ft.	Per Ft.
1100	RG 8 95% Shielded Mil. Spec.	28.00	32
1102	RG8 95% Shielded Foam	30.00	32
1110	RG8X 95% Shield (mini 8)	15.00	17
1130	RG213/U Mil. Spec. 96% Shield	34.00	36
1140	RG214/U Mil. Spec. Dbl. Silver	155.00	165
1180	Belden 9913 Low Loss	46.00	50
1705	RG142B/U Teflon/Silver	140.00	150
1310	RG217/U 5/8" 50 ohm Dbl. Shield	80.00	85
1470	RG223/U Mil. Spec. Dbl. Silver	80.00	85
1450	RG174 95% Shielded Mil. Spec.	12.00	14

ROTOR CABLE — 8 COND.

Nemal No.	Description	100 Ft.	Per Ft.
8C1822	2-18 Ga., 6-22 Ga.	19.00	21
8C1620	2-16 Ga., 6-20 Ga. Heavy Duty	34.00	36

* Shipping \$3.00 — 100 Ft. / Conn. \$3.00 / C.O.D. \$2.00

CONNECTORS — MADE IN U.S.A.

Nemal No.	Description	Each
NE720	Type N for Belden 9913	4.25
NE723	N Female Belden 9913	4.75
PL258AM	Amphenol Barrel	1.45
PL259	Standard Plug for RG8, 213	10/5.90 or 65
PL259AM	Amphenol PL259	10/7.90 or 89
PL259TS	PL259 Teflon/Silver	1.59
UG210	Type N for RG8, 213, 214	3.00
UG838	N Female to PL259	6.50
UG88C	BNC RG58	1.25
UG146	S0239 to Male N	6.50
UG175/6	Adapter for RG58/59 (specify)	10/2.00 or 22
UG255	S0239 to BNC Amphenol	3.75
KA51-18	TNC RG58	4.35
AM9501-1	SMA RG142B	8.95
S0239AM	Amphenol S0239	89

GROUND STRAP — BRAID

Nemal No.	Description	Per Ft.
GS38	3/8" Tinned Copper	30
GS12	1/2" Tinned Copper	40
GS316	3/16" Tinned Copper	15
GS316S	3/16" Silver Plated	35

GROUND WIRE — STRANDED

Nemal No.	Description	Per Ft.
HW06	6 Ga. insulated stranded	35

Call or write for complete price list. Nemal's 32-page Cable & Connector Selection Guide is available at no charge with orders of \$50.00 or more, or at a cost of \$4.00 individually.

NEMAL ELECTRONICS, INC.

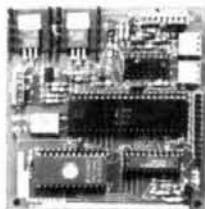
12240 N.E. 14 Ave., No. Miami, FL 33161

(305) 893-3924 • Telex 6975377

✓ 170

24-Hr. FAX (305) 895-8178

MICROCOMPUTER REPEATER CONTROL



\$129

✓ 172

Introducing the MICRO REPEATER CONTROL RPT-2A, a new concept in LOW COST, EASY TO INTERFACE, microcomputer repeater control. Replace old logic boards with a state of the art microcomputer that adds NEW FEATURES, HIGH RELIABILITY, LOW POWER, SMALL SIZE, and FULL DOCUMENTATION to your system. Direct interface (drop in) with most repeaters. Detailed interface information included. Original MICRO REPEATER CONTROL article featured in QST Dec. 1983.

- Two CW ID Messages
- Time Out Timer
- Pre Timeout Warning MSG
- Courtesy Bleep
- Auxiliary Inputs
- Reconfigurable COR Input
- High Current PTT Interface
- Sine Wave Tone Generator
- Low Power 9.15 VDC @ 200 ma
- Size 3.5" x 3.5"
- All Connectors Included!

RPT-2A Kit Only \$129 plus \$3.00 shipping

PROCESSOR CONCEPTS

P.O. BOX 26023

ST. PAUL, MN 55126

(612) 484-9176 7pm-10pm evenings



CALL OR WRITE FOR FREE CATALOG AND SPECIFICATIONS

"INSTANT" MORSE CODE

Beginners:
Deliciously Easy

Experts:
Automatically Fast

**CURLYCODE™ MANUAL
ONLY \$6.50**

Guaranteed

✓ 171



Minds eye Publications
Dept. H27, Suite 115-199
1350 Beverly Rd.
McLean, VA 22101



A Publication
for the Radio Amateur
Especially Covering VHF,
UHF and Microwaves

English Language Magazine Published in Germany 4 Times Yearly. Available Again in the U.S.

1 Year Subscription.....\$20.00
SAMPLE Issue (U.S. only).....\$4.00

Single Copies \$5.00 each at Better Amateur Dealers or Send for FREE Brochure with Partial Article Index.

KITS are Available for Published Project Articles**

Write Today **U V COMMS**
Dept. H, P.O. Box 432
Lanham, MD 20706 (301) 459-4924
K3BRS

MISSOURI RADIO CENTER

102 N.W. Business Park Lane, Kansas City, MO 64150 816-741-8118

Call Toll Free — 9am - 6pm Mon. - Fri., 9am - 2pm Sat.
In Missouri Call — 816-741-8118

1-800-821-7323

TRADE INS ACCEPTED
MasterCard — VISA — COD Welcome

KENWOOD



TS940S "DX-celence"

- Programmable Scanning
- High Stability, Dual Digital VFO's
- 40 Channel Memory
- General Coverage Receiver

KENWOOD



TS440S "DX-CITING"

- 100% Duty Cycle
 - 100 memories
 - Direct Keyboard Entry
 - Optional Built-in AT
- On Sale Now, Call For Price!

KENWOOD



TM-3530A 220 MHz MOBILE FM TRANSCIVER

- 220-225 MHz with 25 Watts
- 7-Digit Telephone No. Memory
- Direct Frequency Entry
- 23-Channel Memory

KENWOOD



NEW TH-215A

"FULL FEATURED 2m HT"

- 141-163 MHz Receive
- 144-148 MHz Transmit
- 2.5w Output (5w Optional)
- 10 Memories
- Built-in CTCSS Encoder
- Nine Types of Scanning

YAESU



FT-757GX "CAT SYSTEM"

- All Mode Transceiver
 - Dual VFO's
 - Full Break-in CW
 - 100% Duty Cycle
- CALL FOR BEST PRICE!

YAESU



FT-767GX HF/VHF/UHF BASE STATION

- Add Optional 6m, 2m & 70cm Modules
- Dual VFO's
- Full CW Break-in
- Lots More Features

YAESU

FT23/73R

- Zinc-Aluminum Alloy Case
- 10 Memories
- 140-164 MHz, 440-450 MHz
- 600 MAh Standard Opt. 5w New "super handle"



YAESU



FT-109RH 220 MHz H.T.

- 5 Watts Output
- Battery Saver
- 10 Memories
- Multiple Scanning Routines
- Power Meter

ICOM



IC-735 "NEW"

Can you put a price tag on reliability? Now ICOM offers a ONE YEAR WARRANTY on its HF Transceivers & Receivers purchased after August 1, 1986.

ICOM



IC-751A "NEW"

- 100 KHz - 30 MHz
- FM Standard
- 32 Memories
- QSK (Nominal Speed 40 WPM)

ICOM



IC-38A

- Full 25W, 5W low
 - 21 memories
 - Subtones built in RX 215-230 MHz
- CALL FOR BEST PRICE

ICOM



IC-μ2AT

- 140-163 MHz
- 10 Memories
- 1W, 1.5W optional
- 32 tones built-in

IC-03AT

- 220 to 224.995 MHz
- 2.5W, 5W Optional
- Built in subtone
- 10 Memories

Kantronics



KAM

Kantronics All Mode

- CW, RTTY, ASCII, AMTOR, HF & VHF Packet
- RS-232/TTL, Universal Compatibility
- Transmit and Receive CW 6-99 wpm, RTTY/ASCII 45-300 Baud, ARQ, FEC, SELFEQ, Listen ARQ, VHF and HF Packet



MFJ-1274

TNC 2 PACKET RADIO

- VHF and HF Packet
- Precision Tuning Indicator
- AX .25 Level 2 Version 2 Software
- TTL Serial Port
- More!

MFJ

NOVICES

ARE YOU CONFUSED ABOUT YOUR NEW PRIVILEGES? CALL US FOR THE UP-TO-THE-MINUTE INFORMATION AND ASSISTANCE WITH YOUR GEAR.

✓ 168

AAA



PK 232

- Make any RS-232 compatible computer or terminal a complete digital operating position.
- Morse, Baudot, ASCII, AMTOR, Packet
- Loaded with features.

ASTRON CORPORATION



Power Supply

- RS7A \$48
- RS12A \$68
- RS20A \$88
- RS20M \$105
- VS20M \$125
- RS35A \$133
- RS35M \$149
- VS35M \$165
- RS50A \$189
- RS50M \$215
- RM50A \$219
- VS50M \$229

HUSTLER

HYGAIN

ICOM

• MOST ORDERS SHIPPED SAME DAY •

J.I.L.

KANTRONICS

KDK

Many home computer programs are now available for determining the six-character grid square for any point on Earth if the latitude and longitude are known. Conversely, there are now computer programs that will break out the longitude and latitude from a six-character grid square. Some of the programs will even determine the distance and bearing between two stations if the grid squares are known.

It's now common practice on 6 meters and above to exchange your four-digit locator or grid square when establishing initial contact with a new station. In fact, the use of grid squares has become so widespread in North America that one often has to ask the other station in which state they're located!

VHF/UHF/microwave awards

As previously mentioned, the WAS award is still very popular in North America on the VHF frequencies. WAS has been obtained by several hundred Amateurs on 6 meters using ionospheric propagation. WAS has been attained on 2 meters by almost 100 Amateurs, but EME was needed because the distance necessary to work all states exceeds the normal propagation modes even for those located in the central part of the United States. Likewise, about ten WAS awards have been attained on 135 and 70 cm using all available normal propagation modes and EME.

The WAC (Worked All Continents) award is also available on VHF. Many 6-meter WACs have been issued, especially after the F2 propagation peaked a few years ago. WAC has also been accomplished by several dozen stations on 2 meters and 70 cm, but EME was required. Several stations are now waiting for the arrival of a South American Amateur on 23-cm EME to complete WAC on that band.

In 1981 the Central States VHF Society started an awards program using squares similar to those used in Europe. This scheme was eventually adopted by the ARRL; on January 1, 1983, they launched a new VHF

Table 2. Number of grid squares required for ARRL VUCC award.

Frequency	Grids Required	Endorsement increments
50 MHz	100	25
144 MHz	100	25
220 MHz	50	10
432 MHz	50	10
902 MHz	25	5
1296 MHz	25	5
2.3 GHz	10	5
3.4 GHz	5	5
5.7 GHz	5	5
10 GHz	5	5
24 GHz	5	5
47 GHz	5	5

awards program called the VUCC (VHF/UHF Century Club).⁵ Based on the Maidenhead QTH locator system, it's the DXCC of the VHF world.

Each VHF band through 47 GHz now has its own separate VUCC award. Only confirmed contacts made on or after January 1, 1983 qualify. The minimum number of confirmed grid squares varies for each band, with the minimum established according to the degree of difficulty involved. Six and 2 meters require at least 100 grids, while 135 and 70 cm each require 50 grids. Stickers are available for specific levels above the minimum requirements.

Table 2 has been prepared to show the minimum number of grid squares required on each of the designated bands as well as the endorsement sticker requirements. Unlike the DXCC, for which several of us have already confirmed all 317 presently designated countries, the VUCC Award has 32,400 grid squares available for each of the bands shown in table 2. That should keep most VHFers busy for the foreseeable future!

Think of the excitement you could have with a North or South Pole expedition, where you could put out 18 different squares just by moving your station a few feet for each square. Better yet, sit right over the Pole and put out all 18 polar squares simultaneously! What say, KC4AAA?

For those interested in the worldwide grid squares, Folke Rosvall, SM5AGM, has published a World At-

las showing all 32,400 grids superimposed on maps of the world along with principal cities and geographic boundaries.⁶ I find this atlas indispensable for serious grid square work.

DX records

Ironically, *the most prestigious accomplishments on VHF have no awards!* The ultimate claim is to be one of the few who can document the best DX on a particular VHF frequency band. For many years this was done on a worldwide basis and hence the chance to claim a record was slim unless you lived near one of the strategic locations favored by one of the exotic propagation modes.

Therefore, in the July, 1985 column I introduced a North American-only DX record list.¹ This gave North American Amateurs a means of comparing their accomplishments more equitably with their peers. Furthermore, I added a twist by listing the records according to the suspected mode of propagation. This not only created many more mountains to climb, but also distributed the records according to the most favorable propagation in different regions of North America. Judging from all the calls and letters, this listing has generated substantial enthusiasm for new record challenges.

Occasionally I hear second-hand claims that individuals have or know of longer records, but are either unable or unwilling to produce the necessary material to document their case. Claims come cheap, so I disregard

Table 3. North American VHF and above claimed DX records (revised March 18, 1987).

Frequency	Record Holders	Date	Mode	Miles (km)
50 MHz	Note 3			
144 MHz				
Aurora	KA1ZE (FN31TU)-WB0DRL (EM18CT)	86-02-08	cw	1347 (2167)
Ducting	KH6GRU (BL01XH)-WA6JRA (DM13BT)	73-07-29	cw	2586 (4161)
EME	VE1UT (FN63XV)-VK5MC (QF02EJ)	84-04-07	cw	10,985 (17676)
Sporadic E	W4EQR (EM60IM)-W7HAH (DN28NB)	81-07-09	ssb	1891 (3043)
FAI	W5HUQ/4 (EM90GC)-W5UN (DM82WA)	83-07-25	cw	1229 (1977)
MS	K5UR (EM35WA)-KP4EK (FK68VG)	85-12-13	ssb	1960 (3153)
TE	KP4EOR (FK78AJ)-LU5DJZ (GM04RO)	78-02-12	ssb	3933 (6328)
Tropo	K1RJH (FN31X1)-K5WXZ (EM12QW)	68-10-08	cw	1465 (2358)
220 MHz				
Aurora	W3IY/4 (FM19HA)-WB5LUA (EM13QC)	82-07-14	cw	1145 (1842)
Ducting	KH6UK (BL11AQ)-W6NLZ (DM03TS)	59-06-22	cw	2539 (4086)
EME	K1WHS (FM43MK)-KH6BFZ (BL11CJ)	83-11-17	cw	5058 (8139)
MS	K1WHS (FM43MK)-K0ALL (EN16NX)	85-08-12	ssb	1279 (2057)
TE	KP4EOR (FK78AJ)-LU7DJZ (GM04RO)	83-03-09	cw/ssb	3670 (5906)
Tropo	VE3EMS (EN86QJ)-WB5LUA (EM13QC)	82-09-28	ssb	1181 (1901)
432 MHz				
Aurora	W3IP (FM19PD)-WB5LUA (EM13QC)	86-02-08	cw	1182 (1901)
Ducting	KD6R (DM13NI)-KH6IAA/P (BK29GO)	80-07-28	cw	2550 (4103)
EME	K2UYH (FN20OF)-VK6ZT (QF78VB)	83-01-29	cw	11,567 (18612)
MS	W2AZL (FN20VI)-W0LER (EN35IE)	72-08-12	cw	1020 (1641)
Tropo	WB3CZG (FN21AX)-WA5VJB (EM12LQ)	86-11-29	ssb	1318 (2121)
903 MHz				
Tropo	W2PGC (FN02OR)-K3SIW/9 (EN52WA)	86-12-24	ssb	478 (769)
1296 MHz				
Ducting	KH6HME (BG29GO)-WB6NMT (DM12KU)	86-08-13	ssb	2528 (4068)
EME	K2UYH (FN20QG)-VK5MC (QF02EJ)	81-12-06	cw	10,562 (16995)
Tropo	WB3CZG (FN21AW)-KD5RO (EM13PA)	86-11-29	cw	1287 (2070)
2304 MHz				
EME	PA0SSB(JO11WI)-W6YFK (CM87WI)	81-04-05	cw	5492 (8837)
Tropo	KD5RO (EM13PA)-W8YIO (EN82BE)	86-11-29	cw	940 (1531)
3456 MHz				
Tropo	WA5TNY/5 (EM11AU)-WB5LUA/5 (EM24UQ)	86-10-19	cw	288 (464)
5760 MHz				
Tropo	K5PJR (EM26OP)-WA5CIW/5 (EM04HX)	86-11-22	cw/ssb	285 (459)
10.368 GHz				
Tropo	WA4GHK/4 (EL97SV)-WD4NGG (EM92PE)	84-08-07	FM	297 (478)
24.192 GHz				
LOS	WA3RMX/7 (CN93IQ)-WB7UNU/7 (CN95DH)	86-08-23	ssb	115.5 (186)
47.040 GHz				
LOS	WA3RMX/K7RUN (CN85OL)-WB7UNU/W7TYR/W7ADV (CN85PL)	87-03-07	ssb	5.42 (8.72)
76-149 GHz	None reported			
474 THz				
LOS	K6MEP (DM04IO)-WA6EJO (DM04KT)	79-06-09	Laser	15 (24)

Notes:

1. The records are listed alphabetically by mode. Ducting is suspected when the path is mostly over water. No efforts are made to separate out ducting on overland paths, so they're grouped under tropo.
2. The information within the brackets is the grid square locator.
3. Six-meter records were omitted since the primary mode is often hard to distinguish. Also, long-path QSOs exceeding 12,433 miles (20,004 km) were reported during solar cycles 19 and 21.

them unless the proof can be obtained. All record claims must be two-way contacts on recognized Amateur bands using legal power.

Since the last North American claimed records list was published in January, 1987, there have been many changes; the pace quickens to increase records even if only by a few more miles.⁷ **Table 3** shows the latest VHF and above record claims. I've also added a further refinement by listing (to the best of the information received) the six-character grid square location on each end of the record.

Again, I offer a challenge. If you think you've bettered one of the records shown, send me a note with some pertinent information on the claim and I'll return a record claim sheet for verification. Fair enough?

QSLing

Yes, QSLs are required for most awards, even on the VHF frequencies. QSLs can be revered; unfortunately, they're worthless if improperly documented. Show pride — not only in your QSL, but in paying attention to the details on the QSL. Always include the following minimum information on your QSL cards: your call sign, the other station's call, your QTH and grid square, the date and time of your QSO, plus your frequency and emission type. The following additional information is also recommended: the propagation mode, a signal report (try to note this in your log even though it may not be used at the time — during contests, for example); your six-character grid square or exact latitude and longitude, a description of your equipment, some comment on the weather, and any other pertinent information. The latter information could immensely assist others who are trying to evaluate propagation or station performance.

Always use UTC time and date. There's a special problem on 6 meters in North America, since over half the sporadic E openings occur in the early evenings between 2200 and 0300 UTC, during which the date changes! There's nothing more frustrating than

trying to verify a QSO in your log when there are 50 to 100 QSOs (or more during contests), all on the same date, and you get a QSL from another time zone. *UTC is universal.* If UTC is a problem to figure, buy an inexpensive clock just for logging and set it on UTC, as given by radio station WWV. Note the UTC date; it's just as important as the UTC time!

Finally, be careful when dating QSLs so there's no ambiguity about the month and day. Many years ago dates were customarily given as month-day-year (for example, 6/12/87); slowly the trend has changed to day-month-year (that is, 16/6/87). Now there seems to be a feeling internationally that this is confusing.

The newest date system suggested by the IARU (and by many governments) is to indicate dates by stating the most important parameter, namely the year, first. The month and day follow (for example, 87/6/16). I now use this format in my log and had my latest QSLs printed this way. There's no longer any confusion about which part of the date is being numbered, especially when exchanging QSLs internationally. Don't you agree?

I often receive QSLs sent as postcards. Quite frankly, most of these arrive looking as if they'd been through a meat grinder and are often illegible, with postage stamps obscuring important information — such as the date! I strongly recommend that you show a little pride and always send QSLs in a protective envelope even though the cost will be higher.

Please answer all QSLs received on the VHF bands. What may seem like an easy contact to you may have been like climbing a mountain for the other person. QSL as soon as possible after a contact; the longer you wait, the less chance of a return. We live in a mobile society. People move, lose interest, and often postpone answering QSLs, especially if a large batch arrives.

Finally, don't forget the SASE. QSLing is no longer an inexpensive proposition. If you want a reasonable

guarantee of a QSL in return, including an SASE is the least you can do. One exception is when both parties want a card and mutually agree ahead of time to dispense with the SASEs.

what constitutes a QSO?

Does this sound like a stupid question? I don't think so — not when it's applied to VHF and above. With the arrival of new operating techniques and the use of more exotic propagation mechanisms, many QSOs are no longer straightforward and may require more than a few seconds to complete. It may be more a matter of minutes or even hours.

Let me be more specific. I believe that the minimum requirements for a valid contact are a two-way exchange of both call signs, some type of information, and a confirmation that all this information was received.

The call sign exchange should be obvious. If both call signs aren't heard by both stations, how can you be sure who you're communicating with — especially if signals are weak? I totally deplore the often single-call contest type of contacts, presently so popular on hf and beginning to appear on VHF.

When you call a station for the first time, send his or her call sign followed by your call sign. If several stations call simultaneously (such as in reply to a CQ), there may be confusion. It's often easier and quicker to sign both calls twice, once at the beginning and once at the end of the first information exchange, rather than repeat them in QRM if two stations reply.

The exchange of some specific information may require some amplification. On hf and often on VHF, this is usually a signal report such as RS(T). Nowadays, it's popular on VHF and above to just exchange grid squares. There's nothing wrong with this. On EME and meteor scatter, the exchange is usually a letter or abbreviated report such as "S2" on meteor scatter. Again, there's nothing wrong with this as long as it's mutually understood by the two stations having the contact.

The exchange of information shouldn't be sent until the call signs are

confirmed. After the information exchange, the most crucial part of the contact takes place; this is the confirmation that all the necessary information has been received. Frequently this is accomplished by an "R" on CW or "roger" on SSB.

Most operators agree that the roger should never be sent until both call signs and all the information exchange is completed. Furthermore, most operators agree that the contact is complete when at least one of the stations hears a roger and then responds with same. Some purists may want to hear rogers both ways, but that can lead into the roger-of-the-roger syndrome.

If there's any doubt about the confirmation required, try to get a definition of what the other station requires ahead of time. One scheme I use to break the routine is to send 73, but I never send it unless I'm sure that the other station has received my roger. When you hear my 73, you know that I've received all the necessary ingredients for a completed QSO.

transmission modes

Nowadays most weak-signal communications use SSB on the VHF/UHF frequencies because it has a much faster information exchange. This is especially true on meteor scatter, where some bursts are measured in seconds. CW is usually reserved for long-haul, weak-signal paths, EME, and aurora, where signals are more difficult to copy, especially when there's severe distortion or doppler shift.

More specific information is required to operate meteor scatter and EME because they each have a special reporting format. On meteor scatter contacts, stations in North America usually transmit and receive in 15-second increments. Generally speaking, the station furthest west or south transmits the first and third 15 seconds of each minute and the station furthest east or north transmits the second and fourth 15 seconds. More specifics are discussed in reference 8.

EME operation is another matter because it differs on each band. Trans-

Table 4. Suggested activity nights and contest activity hours (see text).

Band	Activity Night	Activity hours during contests
6 meters	Sunday	6 AM/PM
2 meters	Monday	7 AM/PM and 1 PM
135 cm	Tuesday	8 AM/PM and 2 PM
70 cm	Wednesday	9 AM/PM and 3 PM
23 cm	Thursday	10 AM/PM and 4 PM
33 cm	Friday	11 AM/PM and 5 PM

mission periods are typically 2 or 2-1/2 minutes and special reporting sequences are used. 70-cm reporting and scheduling are discussed in reference 9. Time and space won't allow a lengthy dissertation at this time, so these matters will have to be covered at a later date.

when and where to operate

So far I've discussed band plans, grid squares, awards, QSLing, and what constitutes a two-way contact. By now you're probably asking, "Where do I go to find all those stations to contact?" One answer is to tune into the various calling frequencies and scan 10 to 25 kHz on either side of them. If nothing is heard, try a CQ on one of the calling frequencies.

If you still don't hear anyone, don't be alarmed. Your rig is probably working, but there just isn't any activity at the time. "So when is the activity?" you ask. The answer is sometimes a function of your location. You may have to be patient at first or ask a local Amateur when it all takes place.

• **Activity nights.** Sometimes activity can be sparse, especially on the higher VHF and UHF bands. Many of the "dyed-in-the-wool" VHF/UHFers operate on more than one band. But you can't be everywhere all the time — thus the concept of "activity nights."

Basically the scheme goes like this. Each night of the week is designated for a different major VHF/UHF band. This way you can pool your resources and cover all bands equally. This concentration has been proven to be very effective and easy to remember. Sunday night is 6-meter night, Monday is

2-meter night, and so forth; **table 4** shows the whole scheme. Local areas choose the time, but it's typically between 8 and 10 PM local time.

• **Contests** usually provide plenty of VHF/UHF activity. The major North American contests are listed at the end of this column. Again, the operation can get out of sync; that important multiplier may be on a particular band when you're busy elsewhere. Therefore, activity hours are recommended during contests. Here in the Northeast, 7 AM and 7 PM are 2-meter hours, 8 AM and 8 PM are 135-cm hours, and so forth. These times are also shown in **table 4**.

• **Nets** are another source of activity. SMIRK (Six Meter International Radio Klub) and SWOT (Sidewinders On Two) have local nets. Some clubs do the same. AMSAT/OSCAR has hf band nets where VHF/UHFers can be found. This a good way to seek out activity. Six-meter operators can often be found on 28.885 MHz when band openings are expected or for cross-band (6 to 10 meters) operation.

Many special-interest VHF/UHF nets convene on hf so that wider area coverage can be conducted. The Central States VHF Society has a net on 3818 kHz on Sunday evening. I believe it's at 10 PM Central Time. Members and nonmembers can often be found on this frequency in the evenings, especially during meteor showers. The 70-cm EME net meets on 14.345 MHz every Saturday and Sunday at 1600 UTC, followed by the 2-meter EME net at approximately 1700 UTC.

• **VHF/UHF and microwave conferences**, many held annually, are usually listed at the end of each month's column (if I get the informa-

tion in time). Conferences are a great way to meet other VHF/UHFers and to get tips on operating a station, improving your equipment, schedules, and activity.

Another nice thing about VHF/UHF/microwave conferences is that they often have noise figure measurement gear so you can tweak your preamplifiers and know how good (or bad) they really are. Often antenna measurement is available. This is a good way to see how your favorite antenna stacks up against the competition.

• **Publications** offer another great source of activity. All the major Amateur journals in the United States now have special VHF columns. In addition, there are literally dozens of club newsletters, magazines, and specialized publications that are good for locating activity and finding out how to improve your gear. Many of these were discussed in my March, 1985 column, so they won't be repeated here.¹⁰

At the risk of leaving someone out, I've prepared table 5, which lists some of the major North American VHF/UHF newsletters not connected directly with any club or organization. If there's interest in updating the information in reference 10 or listing the various club newsletters, let me know. Just send me the information on your publication; perhaps we can publish it at a later date.

join a club or society

If you really want to get involved and meet people, join one of the many VHF/UHF or microwave clubs or societies. They range from small groups of several individuals sharing a newsletter to larger ones with hundreds of members who sponsor conferences. This is an excellent way to get tips on operating.

Again, it would be difficult to list all the clubs and societies. My list is incomplete at this time. If you're not already sending me your newsletter, please send a sample copy and information on joining. Perhaps we can run lists of these in a future column.

Table 5. Several major North American newsletters that are not directly associated with a club or organization.

VHF/UHF and Above Information Exchange, c/o Rusty Landes, KA0HPK, P.O. Box 270, West Terre Haute, Indiana 47885. Issued monthly. One-year subscription: \$15.00.

KC0W's UHF-Plus Update, 3090 Point Pleasant Road, Hebron, Kentucky 41048. Issued monthly. One-year subscription: \$5.00.

220 Notes, c/o Walt Altus, WD9GCR, 215 Villa Road, Streamwood, Illinois 60103. Issued quarterly. One-year subscription: \$5.00.

2-Meter EME Bulletin, c/o Gene Shea, KB7Q, 417 Staudaer Street, Bozeman, Montana 59715. Issued monthly. One-year subscription: \$15.00.

conveniences

All your operation can go for naught if some conveniences aren't provided. Try to make your operating position as comfortable as possible. Have a separate light over the operating position so that your log book can easily be seen. It will not only be less tiring, but safer if you have to make any gear changes.

Have keys and microphones readily accessible on the operating table. If any antennas have to be switched, provide a switch, preferably with easy access from the operating position. Don't take any shortcuts on an antenna relay. A poor isolation or unreliable relay can cause instant equipment burnout.

Finally, if possible, have a secondary frequency standard.¹¹ Not only will it tell you what frequency you're on, but it will provide a weak signal source to indicate whether your gear is grossly inoperative.

summary

This month's column, devoted to operating a VHF/UHF/microwave station, was further dedicated to newcomers to ease and speed their transition to the VHF and above frequencies. Various tips for improving your chances of success were also offered.

Remember to let me know about

any VHF/UHF/microwave clubs, societies, newsletters, and conferences. I'll be glad to share the information I receive in a future column.

new records

Reference 7 indicated that the best reported DX on 48 GHz in North America was a puny 0.3 miles. That's all history now, as you'll note in **table 3**. That record was broken on March 7, 1987 when WB7UNU, W7TYR, and W7ADV in Portland, Oregon (CN85PL), had a two-way SSB contact on 47.040 GHz with WA3RMX and K7RUN in Beaverton, Oregon (CN85OL), over a distance of 5.42 miles!

Not only is this a new North American record, but it probably represents the highest frequency at which narrowband SSB communications has ever taken place. The power was only 44 microwatts into a 9.5-inch diameter dish on one end of the path! The power on the other end of the path was 3.5 milliwatts (QRO!) into a 28.5-inch dish. Judging from the signal strength and low power, this same group has immediate plans to break their own record. Congratulations all around and good luck on your next record attempt.

Important VHF/UHF Events

July 1	± 1 month. Look for European 6-meter opening.
July 11	EME perigee
July 18-19	CQ Magazine VHF WPX Contest
July 20	± 2 weeks. Look for 2-meter sporadic E propagation.
July 23-26	Central States VHF Conference, Arlington, Texas (contact KD5RO)
July 29	Predicted peak of the Delta Aquarids meteor shower at 1500 UTC
Aug. 1-2	ARRL UHF Contest
Aug. 1-3	SWOT (Sidewinders On Two) open QSO party (contact K5IS)
Aug. 8	EME perigee
Aug. 12	Predicted peak of the Perseids meteor shower at 1300 UTC

references

1. Joe Reisert, W1JR, "VHF/UHF World: VHF/UHF Propagation Update," *ham radio*, July, 1985, page 86.
2. Joe Reisert, W1JR, "VHF/UHF World: Microwave and Millimeter-Wave Propagation — Part I," *ham radio*, July, 1986, page 82.

3. Richard K. Palm, K1CE, editor, *The FCC Rule Book*, an ARRL publication, available from Ham Radio's Bookstore for \$4.00 plus \$3.50 shipping and handling.
4. Bart J. Jahnke, KB9NM, editor, *The ARRL Repeater Directory*, 1986-1987 edition, an ARRL publication. 1987-1988 edition available from Ham Radio's Bookstore for \$4.00 plus \$3.50 shipping and handling.
5. John F. Lindholm, W1XX, "VHF/UHF Century Club Awards," *QST*, January, 1983, page 49.
6. Folke Rosvall, *The Radio Amateur's World Atlas*, available from Ham Radio's Bookstore for \$4.00 plus \$2.00 shipping and handling.
7. Joe Reisert, W1JR, "VHF/UHF World: Microwave and Millimeter-Wave Update," *ham radio*, January, 1987, page 63.
8. Joe Reisert, W1JR, "VHF/UHF World: Improving Meteor Scatter Communications," *ham radio*, June, 1984, page 82.
9. Joe Reisert, W1JR, "Requirements and Recommendations for 70-cm EME," *ham radio*, June, 1982, page 12.
10. Joe Reisert, W1JR, "VHF/UHF World: Keeping VHF/UHFers Up to Date," *ham radio*, March, 1985, page 126.
11. Joe Reisert, W1JR, "VHF/UHF World: VHF/UHF Frequency Calibrator," *ham radio*, October, 1984, page 55.

ham radio

important news about MININEC 3

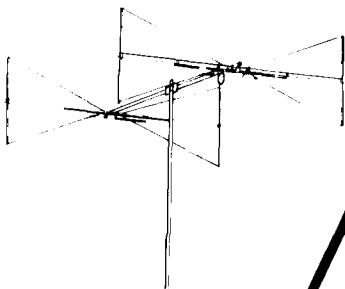
In W1JR's column in the May, 1987 issue (see page 101), it was erroneously stated that copies of MININEC 3 could be obtained from the United States Naval Ocean Systems Center (NAVOCEANSYSCEN).

According to NAVOCEANSYSCEN, engineering software such as MININEC is developed by NAVOCEANSYSCEN for use by the United States Navy and other Department of Defense (DOD) agencies. NAVOCEANSYSCEN software is made available to the DOD and DOD contractors upon written request as part of the technology transfer goals of NAVOCEANSYSCEN.

The documentation for MININEC 3, NOSOC Technical Document No. 938, is available to the general public at a nominal fee from the National Technical Information Service (NTIS). Copies of MININEC 3 on diskette will be available from the Federal Software Exchange Center, a service of NTIS. To request copies, please contact NTIS at 5285 Port Royal Road, Springfield, Virginia 22161 (703 487-4650).

Please note that foreign requests must be handled through appropriate diplomatic channels. — Ed.

The HF4B "Butterfly"™ A Compact Beam for 20-15-12-10 Meters



- Unique design reduces size but **not** performance
- No lossy traps; full element radiates on all bands.
- Retrofit kit for 17 meters coming soon.
- Turns with TV rotor
- Only 17 lbs.

HF ANTENNAS FROM BUTTERNUT

Butternut Verticals

Butternut's HF verticals use highest-Q tuning circuits (not lossy traps!) to outperform all multiband designs of comparable size!

Model HF6V

- 80, 40, 30, 20, 15 and 10 meters automatic bandswitching
- Add-on kit for 17 and 12 meters available now
- 26 ft tall

Model HF2V

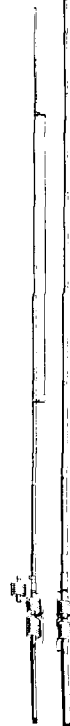
- Designed for the low-band DXer
- Automatic bandswitching on 80 and 40 meters
- Add-on units for 160 and 30 or 20 meters
- 32 feet tall - may be top loaded for additional bandwidth

For more information see your dealer or write for a free brochure



BUTTERNUT ELECTRONICS CO.

405 East Market Lockhart, Texas 78644



17th ANNUAL INDIANAPOLIS HAMFEST™ And INDIANA STATE ARRL CONVENTION



July 11-12, 1987

Marion County Fairgrounds — Gates open 6:00 AM both days

2 Full Days of:

Commercial Exhibitors
Large Flea Market
Hourly Awards
Forums

FREE:

Parking
Kids Awards
Camping
Womens Awards

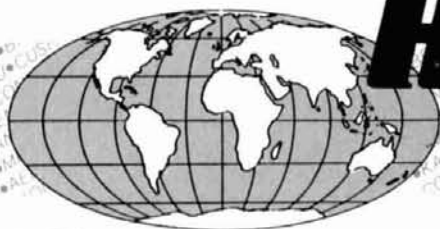
Free Trolley Buses to Union Station
Indiana's Largest Electronic Flea Market,
Computer and Amateur Radio Display

INDIANAPOLIS HAMFEST, P. O. Box 11776, Indianapolis, IN 46201

CALL: (317) 745-6389—Commercial (317) 356-4451—Flea Market

WORLDWIDE DISTRIBUTION

OUR COMMITMENT TO YOU IS
QUALITY, ACTION & SERVICE.



HAM RADIO OUTLET

LARGEST HAM OUTLET IN THE WORLD

7 STORE BUYING POWER

KENWOOD TS-940S



TOP-OF-THE LINE
HF TRANSCEIVER

GREAT PRICE, CALL

KENWOOD TM-3530A



The First Comprehensive
220 MHz FM Transceiver.

ARE YOU READY FOR
220 MHz OPERATION?

HAM RADIO HOME STUDY NOVICE VOICE COURSE



- Updated novice-voice questions
- 6 stereo code & theory cassette tapes
- 2 text books, code oscillator, key & battery
- Color Ham Bands wall chart & frequency list
- Sealed novice exam for a Ham friend to give you the code & theory test in your home
- FCC license application forms & instructions to your examiner. Ideal for spouse & the kids!

\$49.95



MA-40

40' TUBULAR TOWER

\$745 SALE! \$549

MA-550

55' TUBULAR TOWER

\$1245 SALE! \$899

- Handles 10 sq. ft. at 50 mph
- Pleases neighbors with tubular streamlined look

TX-455

55' FREESTANDING
CRANK-UP

- Handles 18 sq. ft. at 50 mph
- No guying required
- Extra-strength Construction
- Can add raising and motor drive accessories

Shown with optional
MARE rotor base

IN STOCK FOR QUICK DELIVERY
OTHER MODELS AT GREAT PRICES

KENWOOD R-5000



High Performance Receiver

- Covers 100 kHz - 30 MHz in 30 bands
- Superior dynamic range
- Computer control option

LOW PRICE!



FT-727R

5w, Dual Band
2m/440 MHz

Enhanced
Version

GREAT PRICE!



Alpha Delta Model DELTA-4

Lightning Surge Protected
4-Position RF Coax Switch

- Exclusive center "off" (ground) position.
- Uses ceramic Arc-Plug® protector.
- Micro-strip circuitry—no wafer switch.



Model DELTA-4
(UHF Connectors) \$69.95

Model DELTA-4/N
(N-type Connectors) \$89.95



30w in, 160w out,
with low-noise
preamp!

MODEL
2M30-160P
for 2 meters
SALE!

\$219.95

From the Originator of the
QUALITY VHF AMP/PREAMP COMBO!

Full Line Now Includes
UHF Models with
GaAs FET PREAMP!



FREE
SHIPMENT
Most items UPS
surface

All Major Brands in Stock Now!

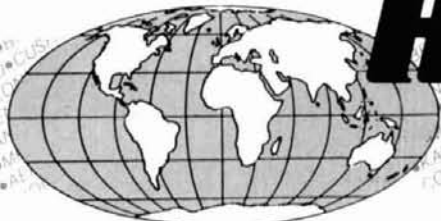
CALL TOLL FREE (800) 854-6046



Toll free including Hawaii. Phone Hrs. 7:00 am to 5:30 p.m. Pacific Time. California, Arizona and Georgia customers call or visit nearest store. California, Arizona and Georgia residents please add sales tax. Prices, specifications, descriptions subject to change without notice.



FULL LINE OF ACCESSORIES IN STOCK.



HAM RADIO OUTLET

LARGEST HAM OUTLET IN THE WORLD

7 STORE BUYING POWER

ICOM IC-761



HF SUPERIOR GRADE TRANSCEIVER

SALE! CALL FOR PRICE

ICOM IC-275A/275H



138 - 174 MHz
IC-275A (25w) IC-275H (100w)

GREAT PRICE!

ICOM IC-1271A



1.2 GHz Transceiver:
The First Full-featured
1240-1300 MHz Transceiver

ARE YOU READY FOR
1.2 GHz OPERATION?

ICOM IC-28A/28H



2-METER MOBILES
IC-28A (25w) IC-28H (45w)

LOW PRICE!

NOW! RAPID DELIVERIES

COAST TO COAST

FROM STORE NEAREST YOU

ICOM HAND-HELD VHF/UHF



IC-02AT IC-2AT 2MTR
IC-03AT IC-3AT 220 MHz
IC-04AT IC-4AT 440 MHz

ICOM IC-735



The Latest in ICOM's Long
Line of HF Transceivers

CALL FOR LOW, LOW PRICE

ICOM IC-R7000



25 MHz-1300 MHz

IN STOCK FOR
IMMEDIATE DELIVERY

ICOM IC-μ2A/μ2AT

Mini
Hand-Held
AT Model
w/ TT Pad

GREAT
PRICE!



All Major Brands in Stock Now!



Bob Ferrero W6RJ
President
Jim Rafferty N6RJ
VP So. Calif Div.
Anaheim Mgr.

ANAHEIM, CA 92801
2620 W. La Palma
(714) 761-3033, (213) 860-2040
Between Disneyland &
Knott's Berry Farm

ATLANTA, GA 30340
6071 Buford Hwy.
(404) 263-0700
Neil, Mgr. KC4MJ
Doraville, 1 mi. north of I-285

BURLINGAME, CA 94010
999 Howard Ave.
(415) 342-5757
George, Mgr. WB6DSV
5 miles south on 101 from SFO

OAKLAND, CA 94606
2210 Livingston St.
(415) 534-5757
Al, Mgr. WA6SYK
17N-5th Ave./17S-16th Ave.

PHOENIX, AZ 85015
1702 W. Camelback Rd.
(602) 242-3515
Bob, K7RDH
East of Hwy 17

SAN DIEGO, CA 92123
5375 Kearny Villa Rd.
(619) 560-4900
Tom, Mgr. KM6K
Hwy 163 & Claremont Mesa Blvd.

VAN NUYS, CA 91411
6265 Sepulveda Blvd.
(818) 988-2212
Al, Mgr. K6YRA
San Diego Fwy
at Victory Blvd

STORE HOURS
10 AM-5:30 PM
CLOSED SUNDAYS



CALL TOLL FREE (800) 854-6046

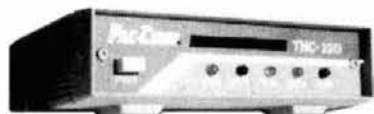
Toll free including Hawaii. Phone Hrs: 7:00 am to 5:30 p.m. Pacific Time. California, Arizona and Georgia customers call or visit nearest store. California, Arizona and Georgia residents please add sales tax. Prices, specifications, descriptions subject to change without notice.



PAC-COMM TNC-220

HF/VHF PACKET CONTROLLER

MADE IN U.S.A.



Shown with
Tuning Indicator
Option

AMATEUR DIRECT PRICES
KIT \$129.95
ASSEMBLED \$159.95
OPTIONS: 32K RAM \$9.95
INTERNAL LED BAR GRAPH
TUNING INDICATOR \$39.95



Rear Panel
Showing Dual
Radio Connectors

YOUR BEST VALUE—COMPARE FEATURES

- Only unit under \$300 with dual radio connectors
- Switch radios, data rates, modem tones with one keyboard command—no buttons to push, no cables to swap
- Six pole HF filter standard—needs no "add-ons"
- Software selectable carrier detection—use software method, amplitude detection, or phase lock (with tuning indicator option)
- Modem disconnect header, CPU high speed clock jumper, expandable to 32K RAM
- Latest version of proven TAPR AX.25 L2V2 software supports 300 to 9600 baud terminal and radio data rates
- Watchdog timer for legal unattended operation, lithium battery backed RAM
- Z80 CPU, 8530 SCC hardware HDLC, 7910 integrated circuit modem
- All ICs socketed
- Direct FSK output available for HF (in addition to AFSK)
- Enhanced software ability to filter connects and digipeating
- LED bar graph tuning indicator option with phase locked loop carrier detection for unsurpassed HF operation
- Works with any TTL or RS-232 computer (no additional interface for VIC-20 or C-64)
- Excellent customer support—24 hour technical hotline, electronic mail system, low cost repair service
- Assembled units carry one year limited warranty
- Comprehensive manual and convenient instruction card
- High quality extruded aluminum case and colorful front panel
- Dealer inquiries invited.

WRITE FOR CATALOG OF PACKET EQUIPMENT, SOFTWARE AND ACCESSORIES.

ORDER DIRECT 800-223-3511 FREE UPS BROWN



Pac-Comm Packet Radio Systems, 3652 West Cypress St., Tampa, FL 33607

✓ 174

DEALER
INQUIRES
INVITED

ANTENNES
TONNA

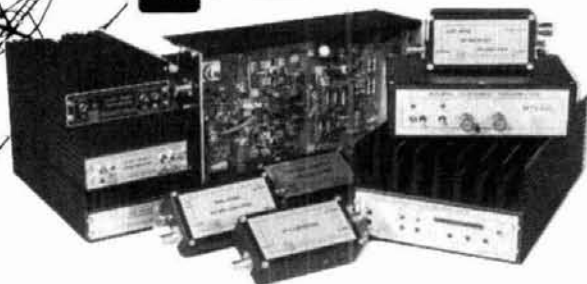
The **X** Shack

52 Stonewyck Drive
Belle Mead, New Jersey 08502

IVARS - KC2PX
MARA - SALES



MICROWAVE MODULES LTD.



HOFT
TONNA

MON-SAT (201) 874-6013

10AM - 3PM ORDERS

7PM - 10PM ORDERS/TECHNICAL

CALL FOR CATALOG

VISA/MASTERCARD

✓ 175

KENNEDY ASSOCIATES

Stocking all major lines. San Antonio's
Ham Store. Great Prices—Great Service.
Factory authorized sales and service.
Hours: M-F 10-6; SAT 9-3

KENWOOD

YAESU



ICOM

Amateur Radio Division
5707A Mobud
San Antonio, TX 78238
Telephone: 512-680-6110



✓ 176

improved gain distribution for the Yaesu FT-726R

Wake up your receiver
with this simple mod

Yaesu's FT-726R is a very popular and well-made radio, offering a lot of flexibility in one small package. But some owners feel that for the 726R to really "come alive" on 2 meters, it's necessary to add an external GaAsFET preamp.

After owning a 726R for several days, I too felt that performance on the 6- and 2-meter bands could be improved. My observations lead me to believe that any shortcomings were not the result of insufficient front-end gain or a high noise figure, but were due instead to an apparent lack of i-f gain in the VHF modules. While the receiver's MDS seemed to be a cut above most other stock transceivers, signals that are too weak to activate the AGC threshold level require the operator to continually ride the a-f gain control for adequate recovered audio. The actual spread between the receiver MDS point and start of AGC action is considerable, resulting in an appreciable weak-signal "dead-zone."

It's interesting to note that the UHF 430- and 440-MHz modules don't suffer from this problem. This is because of the additional overall gain produced by the 70-MHz i-f stages unique to these modules. While switching bands, note how the receiver background noise increases when the UHF module is activated.

does a preamp really help?

I live in Connecticut's "Kilowatt Valley." During contests a multitude of high-power VHF stations surround my QTH and put the best of receivers to the test. The Yaesu 726R uses a single-ended dual-gate FET mixer preceded by a dual-gate FET high-gain amplifier — hardly a "crunch-proof" combination! Whatever benefits offered by a 20-dB GaAsFET preamp would be significantly outweighed by greatly diminished receiver dynamic range.

where gain will do some good

Two cascaded monolithic i-f "roofing" — or IMD — filters follow the first mixer, providing the first real degree of receiver selectivity. These filters protect the subsequent stages from strong signals falling outside the filter passband. While the filter bandwidth isn't adequate for closely spaced SSB/CW signals, the real limiting factor with the 726R lies in its VCO phase noise-produced reciprocal mixing products.

A common-gate JFET stage provides all of the i-f gain in both the 6- and 2-meter modules. Adding another 10 to 15 dB of i-f gain will solve most of the receiver sensitivity problems.

the circuit

Figures 1 and 2, respectively, show the original and modified circuits. An additional FET stage was added to produce the needed gain. While there were many ways to do this, my method involves only minimal disruption of the existing circuitry; the radio may be returned to its original condition without difficulty. *The component values are critical. I deliberately used interstage mismatching and resistive loading to assure predictable gain and a stable circuit.*

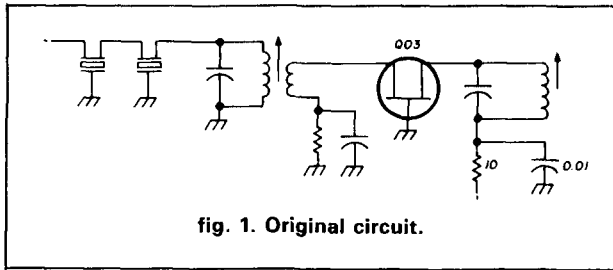
The added components are mounted "cordwood" fashion on the rf unit pc boards for the 2- and 6-meter modules. The modification is neither lengthy nor involved, but some manual dexterity and soldering skills are needed. Don't perform these modifications if you're not comfortable tearing into your radio. Since the rf boards for both VHF modules are nearly identical, and many of the Yaesu part numbers are the same, I'll give the 6-meter information in parentheses only when the part numbers differ.

Only six parts are needed per module; total cost should be about \$10 for both modules. Use 1/8-watt resistors if available, and use the smallest size capacitors you can find. Extremely short, direct connections must be used for stability — there's a fair amount of in-line gain at 10.7 MHz with the additional i-f stage. I suggest pre-tinning the component leads before mounting. Be sure to use a grounded iron.

step-by-step procedure

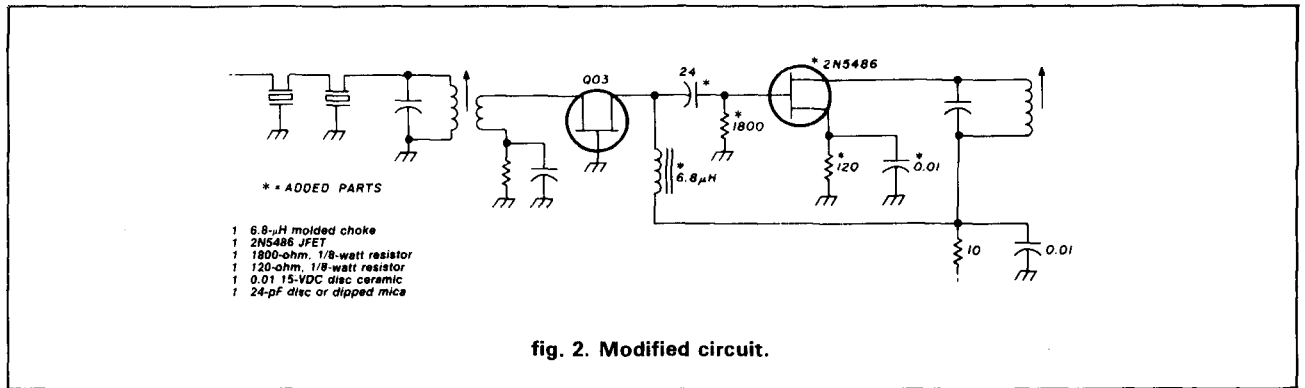
Carefully remove the modules from the radio. Re-

By Peter J. Bertini, K1ZJH, 20 Patsun Road,
Somers, Connecticut 06071



gate lead and ground; use the coil shield for TO9 (TO8 in the 6-meter) as the ground point. Using short leads, tack-solder the 24-pF capacitor between the gate lead of the 2N5486 at the 1.8-k resistor junction and to the junction of the Q03 drain lead and the 6.8- μ H choke. This completes the modification to the radio.

Check your work again for errors, making sure that none of the JFET leads have twisted and shorted together.



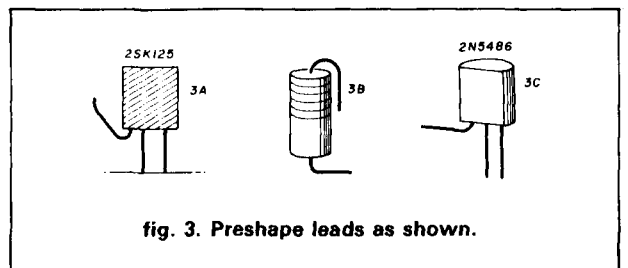
move the top cover shield for the rf board, which is held in place with four screws. Carefully lift the board upwards and locate the drain lead for Q03, the 2SK125 i-f amp. Unsolder this lead carefully and lift it from the pc run. Re-dress the lead as shown in fig. 3A. Because there's a small possibility that the lead may break off at the device case, you may wish to have a few RCA SK replacements on hand.

Preshape the 6.8- μ H choke leads as shown in fig. 3B. Locate the resistor lead on the 10-ohm resistor (R19) nearest capacitor C34 (C32 for 6 meters) and carefully tin the lead. Slide the L-shaped hook lead of the 6.8- μ H choke under the resistor lead and solder. Carefully shape and tack-solder the free drain lead from Q03 to the free choke lead — another lead will be added here later.

Preshape the 2N5486 leads as shown in fig. 3C. Arrange the source and gate leads so they face towards the J02 pin connections and insert the drain lead into the hole previously used by Q03's drain lead. Solder the lead to the PCB run and trim. Check your work carefully. If everything appears to be correct, reinstall the rf board for the 6-meter module only.

A 120-ohm resistor and 0.01 μ F capacitor are installed between the 2N5486 source lead and ground. On the 2-meter module there are holes for an unused i-f transformer that will provide a good short ground path to the pc ground foil. For the 6-meter module the coil shield for i-f transformer TO8 is used; be careful not to overheat the coil assembly. The 2-meter rf board may be reinstalled at this point.

Next, a 1.8-k resistor is installed between the 2N5486



alignment

Connect the module to the radio and let it sit atop the other modules so that the i-f transformers can be aligned. Inject a signal into the receiver that's strong enough to produce S-meter deflection; keep the level under S9 so that small signal variations will be more readily apparent. Carefully repeak coils TO8 and TO9 (coils TO7, TO8, and TO9 for the 6-meter module) for maximum meter deflection; repeat the procedure until no further improvement is noted. There should be no signs of regeneration or oscillation. When alignment is completed, remove power from the radio and reinstall the rf cover shield and the module in the radio.

increased performance

With no antennas connected, the receiver background noise is at the same level regardless of the band selected. Signals are about 10 to 15 dB stronger than before the modification. Weak signals that were difficult to copy are now easy to copy without an external preamp.

ham radio

THE MOST AFFORDABLE REPEATER

ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES

(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

BAND	WIRED	KIT
6M, 2M, 220 UHF	\$880	\$630
	\$980	\$730

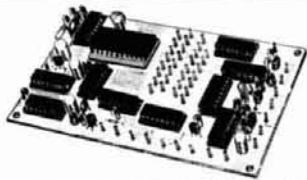
(Also available for commercial bands!)



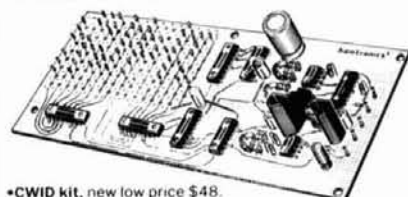
FEATURES:

- **SENSITIVITY SECOND TO NONE!** 0.15uV Typ.
- **SELECTIVITY THAT CAN'T BE BEAT!** Both 8 pole xtal filter & ceramic filter for > 100dB at ±12kHz. Helical resonator front end to combat desense & intermod.
- **Flutter-proof squelch**, Automatic frequency control, separate spkr amplifier.
- **CLEAN, EASY-TUNE TRANSMITTER**, up to 20W output. 50W with additional PA.

ACCESSORIES



- **TD-2 DTMF DECODER/CONTROLLER** kit only \$78. Full 16 digits, 5 functions, toll call restrictor, programmable. Much more. Great for selective calling too!
- **AP-1 AUTOPATCH** kit only \$78. Reverse patch & phone line remote control std.
- **AP-2 Simplex Autopatch**. Use with above.



- **CWID kit**, new low price \$48. Field programmable, timers, the works!
- **COR-2 kit**, \$38. Audio mixer, local spkr amplifier, tail & time-out timers.
- **COR-3 kit**, \$48, with courtesy beep.



- **MO-202 FSK DATA MODULATOR** kit \$38. Run up to 1200 baud digital or packet radio signals through any FM transmitter.
- **DE-202 FSK DATA DEMODULATOR** kit \$38.

GaAs FET PREAMPS at a fraction of the cost of comparable units!

LNG-(*) GaAs FET PREAMP

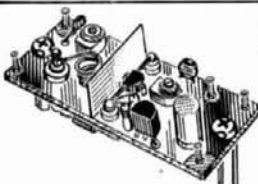
ONLY \$49!

WIRED/TESTED



FEATURES:

- **Very Low Noise:** 0.7dB VHF, 0.8dB UHF
 - **High Gain:** 13-20dB, depending on freq
 - **Wide Dynamic Range:** to resist overload
 - **Stable:** new-type dual-gate GaAs FET
- * Specify tuning range desired: 26-30, 46-56, 137-150, 150-172, 210-230, 400-470, or 800-960 MHz.



LNW-(*) MINIATURE GaAs FET PREAMP

Unbelievably Low Price ---

ONLY \$19/kit, \$34 Wired/tested

GaAs FET Preamp similar to LNG, except designed for **low cost & small size**. Only 5/8" W x 1-5/8" L x 3/4" H. Easily mounts in many radios.

* Specify tuning range desired: 25-35, 35-55, 55-90, 90-120, 120-150, 150-200, 200-270, or 400-500 MHz.

LNS-(*)

IN-LINE PREAMP

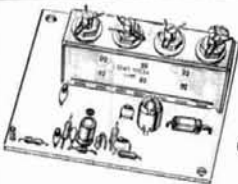


ONLY \$59/kit,

\$79 wired/tested

GaAs FET Preamp with features similar to LNG series, except **automatically switches out of line during transmit**. Use with base or mobile transceivers up to 25W. **Tower mtg. hardware supplied.**

* Specify tuning range desired: 120-175, 200-240, or 400-500 MHz



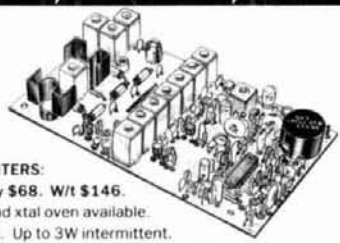
HRA-(*) HELICAL RESONATOR PREAMP

ONLY \$49 VHF or \$64 UHF

Low-noise preamps with helical resonators **reduce intermod & cross-band** interference in critical applications.

* Specify tuning range desired: 143-150, 150-158, 158-162, 162-174, 213-233, 420-450, 450-465, or 465-475 MHz.

HIGH QUALITY XMTR & RCVR MODULES FOR REPEATERS, LINKS, TELEMETRY, ETC.



FM EXCITERS:

- Kits only \$68. W/T \$146.
- TCXO and xtal oven available.
- 2W cont. Up to 3W intermittent.
- **TA51** for 10M, 6M, 2M, 150-174, 220 MHz.
- **TA451** for uhf.
- FCC TYPE ACCEPTED FOR COMMERCIAL BANDS.
- **VHF & UHF LINEAR AMPLIFIERS**. For FM or SSB. Power levels from 10 to 45 Watts. Several models, kits starting at \$78.



R144/R220 FM RCVR

for 2M, 150-174, or 220 MHz. 0.15uV sens, 8-pole xtal & 10 pole ceramic i-f filters, helical resonator front end for exceptional selectivity, > 100dB at ±12kHz (best available anywhere!) Flutter-proof squelch. AFC tracks drifting xmtrs. Xtal oven avail. Kit \$138, w/t \$198.

- **R451 FM RCVR**. Same as above but UHF. Tuned line front end. 0.2uV sensitivity. Kit only \$138, w/t \$198.
- **R76 VHF FM RCVR** for 10M, 6M, 2M, 220. As above, but w/o AFC or hel. Kits only \$98 to \$118.
- **R110 VHF AM RCVR** for VHF aircraft or ham bands or UHF. Kit only \$98.

NOW—FCC TYPE ACCEPTED TRANSMITTERS, RECEIVERS, AND REPEATERS AVAILABLE FOR HIGH-BAND AND UHF. CALL FOR DETAILS.

RECEIVING CONVERTERS



VHF MODELS

Kit with Case \$49
Kit less Case \$39
Wired w/case \$69

Antenna Input Range	Receiver Output
28-32	144-148
50-62	28-30
50-54	144-148
144-146	28-30
145-147	28-30
144-144.4	217-214
146-148	28-30
220-222	28-30
220-224	50-54
222-224	28-30

UHF MODELS

Kit with Case \$59
Kit less Case \$49
Wired w/case \$75

432-434	28-30
435-437	28-30
432-436	144-148
432-438	50-54
439-25	61-25
902-928	422-448
902-922	430-450

TRANSMIT CONVERTERS

Exciter Input Range	Antenna Output
28-30	144-146
28-29	145-146
28-30	50-52
217-214	144-144.4
28-30	220-222
50-54	220-224
144-146	50-52
144-146	28-30

For SSB, CW, ATV, FM, etc. Can be linked with receive conv for transceiver. 1 to 2 W out. Linear PA's available up to 50W.

Exciter Model	Antenna Output
Model XV2 Kit \$79	28-30
Wired \$149 (specify band)	28-30
217-214	144-144.4
28-30	220-222
50-54	220-224
144-146	50-52
144-146	28-30

Exciter Model	Antenna Output
Model XV4 Kit \$79	28-30
Wired \$139	28-30
	432-434
	435-437
	439-25
	61-25
	144-148

HAMTRONICS, INC. 65-E Moul Rd.; Hilton NY 14468-9535

High quality equipment at reasonable prices surely appeals to me; but I want more details before I buy! Rush my copy of the 40-page Hamtronics catalog by return first class mail. I enclose \$1 (\$2 for overseas air mail).

Name _____
Address _____
City _____ State/ZIP _____

- Order by phone or mail • Add \$3 S&H per order (Electronic answering service evenings & weekends)
- Use VISA, MASTERCARD, Check, or UPS COD.

hamtronics, inc.

65-E MOUL ROAD • HILTON NY 14468-9535

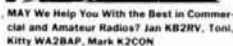
Phone: 716-392-9430

Hamtronics® is a registered trademark

WE SHIP WORLDWIDE
Barry Electronics Corp.
 WORLD WIDE AMATEUR RADIO SINCE 1950
 Your one source for all Radio Equipment!

For the best buys in town call:
212-925-7000
 Los Precios Mas Bajos en
 Nueva York...

KITTY SAYS: WE ARE NOW OPEN 7 DAYS A WEEK.
Saturday & Sunday 10 to 5 P.M.
 Monday-Friday 9 to 6:30 PM Thurs. to 8 PM
 Come to Barry's for the best buys in town.



MAY We Help You With the Best in Commercial and Amateur Radio? Jan KB2HV, Toni, Kitty WA2BAP, Mark K2CON

KENWOOD



TS-440SAT R-5000 R-2000, TS-940 SAT, TM-211A/211A, TM-2570A/50A/30A, TR-751A, Newwood Service (Repair) TH 21-31-41 BT, TS-711A/11A, TM-3530A, TH205AT, TH215A, TW-4100A

NEC-TECH DVM-100 Digital Voice Keyer

Media Mentions... Amateur Radio Coverage \$199.95

VoCom/Mirage/Alicco Tokyo Hi-Power/TE SYSTEMS Amplifiers & 5/8" HT Gain Antennas IN STOCK



48 Watts, \$68

MICROLOG-ART 1, Air Desk, SWL, Morse Coach

KANTRONICS UTU, KAM, UTU-XT, KPC 2400, KPC IV



EIMAC 3-500Z, 572B, 6J56C, 12BY7A & 4-400A

AEA 144 MHz, AEA 220 MHz, AEA 440 MHz, ANTENNAS

BIRD Wattmeters & Elements In Stock

Antennas

YAESU FT-237R/272R, FT-211/109RH, FT-1903/1123

RF Concepts



AMERITRON AMPLIFIER AUTHORIZED DEALER



Computer Interfaces Stocked: MFJ-1270B, MFJ-1272, MFJ-1224, AEA PK-87, PK-64A, PK-64, PM-1, PK-232 W/FAX



ALPHA AMPLIFIERS

Complete Butternut Antenna Inventory In Stock!

DIGITAL FREQUENCY COUNTERS

Trionyx, Model TR-1000, 0-600 MHz

AMP SUPPLY STOCKED

Long range Wireless Telephone for export in stock

BENCHER PADDLES, BALUNS, IN STOCK

MIRAGE AMPLIFIERS

ASTRON POWER SUPPLIES Saxton Wire & Cable

NEW TEN TEC

Corair II, PARAGON, Century 22, RX-325



FT-767GX, FT-980, FT-757GX II, FRG-8800, FT-726, FRG-9600, FT-211/711RH, FT-2700RH

YAESU ICOM Land Mobile HT Midland/Standard Wilson Maxon

YAESU FT-237R/272R, FT-211/109RH, FT-1903/1123, ICOM IC2AT12AT, IC202AT, IC-0304AT, IC-A2U16, Land Mobile HT Midland/Standard Wilson Maxon, Yaesu FT-112, FT-1143, ICOM M5 (Motor) M700 Tempco M-1



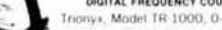
YAESU FTR-2410, Wilson ICOM IC-RP 3010 (440 MHz) ICOM IC-RP 1210 (1.2 GHz)

SANTEC ST 222/UP, ST 20T, SF 442/UP, HT 7



MFG Models 422, 313, 989B, & 941D

SANGEAN Portable Shortwave Radios



HEIL EQUIPMENT IN STOCK

To Ex Towers Hy Gain Towers & Antennas, and Rotors will be shipped direct to you FREE of shipping cost

NEW TEN TEC

Corair II, PARAGON, Century 22, RX-325

ONV Safety belts-in stock



ICOM

IC-771A, 753A, 745, 2B4M, 3BA, 4BA, M4021A, R-7000, IC-761, IC-375A, 2750A-H, 3700A, 8750A-H, 735, IC-9600

SMART PATCH

CE-5 Simplex Auto Patch 510 SA With Patch FM Transceiver To Your Telephone - Great For Telephone Calls From Mobile To Base Simplex Only

PRIVATE PATCH III, Duplex 8000 in Stock

Budwig ANT. Products

FLUKE 77 Multimeter

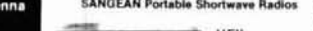
Nye MBV-A 3 Kilowatt Tuner



Ten-Tec Tuner 229B

MFG Models 422, 313, 989B, & 941D

SANGEAN Portable Shortwave Radios



HEIL EQUIPMENT IN STOCK

To Ex Towers Hy Gain Towers & Antennas, and Rotors will be shipped direct to you FREE of shipping cost

NEW TEN TEC

Corair II, PARAGON, Century 22, RX-325

ESTABLISH A HAM TESTING CENTER IN YOUR AREA

As of 1984, all ham radio license testing is handled by the amateur radio community itself. Teams of three Extra Class volunteer examiners (VE's) can now conduct all ham license upgrade examinations.

W5YI-VEC, the initial national VE Coordinator approved by the FCC, oversees the largest alternative (to the ARRL) testing program in the U.S. You can be a part of it by following the simple testing instructions provided.

Administering Technician through Extra Class examinations is no harder than administering Novice examinations which VE's have done for decades. We offer... fastest VE accreditation, complete instructions, immediate testing... with testing fees (expense reimbursement) shared with the VE team.

Send an SASE today for a VE application if you are an Extra Class amateur and serious about conducting periodic amateur radio examination sessions in your area so that others may upgrade.



W5YI-VEC
 P.O. Box #10101
 Dallas, TX 75207
 (817) 461-6443

Let's get Amateur Radio growing again!

MR. NICAD

REPLACEMENT BATTERIES FOR COMMUNICATIONS

Nickel-Cadmium, Alkaline, Lithium, etc.

ICOM - BP-3 Repack - \$15.00
 BP-2, BP-5, BP-8 Repacks.

NEW HOT ROD PACKS FOR ICOM 2A, 2AT, 02AT, 8 CELL 10v - 800 MAH, 10 CELL 12.5v - 500 MAH.....\$49.95 ea.

Yaesu, Kenwood, Santec, Azden, Tempo, Standard, Cordless Phone etc.

MR. NICAD E.H. YOST & CO.

EVERETT H. YOST RR #1 BOX #37
 KB9X1 SAUK CITY, WI 53583
 (608) 643-3194

send for nicad-battery price list.

178

Barry Electronics Commercial Radio Dept. offers the Best in two-way communications for Businesses, Municipalities, Civil Defense, Broadcasting Companies, Hospitals, etc. Sales and Service for all brands: Maxon, Yaesu, Icom, Tad, Octagon, Regency/Wilson, Midland, Standard, Uniden, Shinway, Fujitsu, Seas, Spillsbury, Neutec, etc. Call or write for information. 212-925-7000.

Iron Powder and Ferrite
TOROIDAL CORES
 Shielding Beads, Shielded Coil Forms
 Ferrite Rods, Pot Cores, Baluns, Etc.

Small Orders Welcome
 Free 'Tech-Data' Flyer

AMIDON Associates Since 1963

12033 Otsego Street, North Hollywood, Calif. 91607

In Germany Elektronikladen, Wilhelm - Meilies Str 88 4930 Detmold 18 West Germany
 In Japan Toyomura Electronics Company, Ltd 7-9 2-Chome Sota-Kanda Chiyoda-Ku Tokyo, Japan

180

BLACK DACRON® POLYESTER ANTENNA ROPE

- UV-PROTECTED
- HIGH ABRASION RESISTANCE
- REQUIRES NO EXPENSIVE POTTING HEADS
- EASY TO TIE & UNTIE KNOTS
- EASY TO CUT WITH OUR HOT KNIFE
- SIZES: 3/32" 3/16" 5/16"
- SATISFIED CUSTOMERS DECLARE EXCELLENCE THROUGHOUT U.S.A.

LET US INTRODUCE OUR DACRON® ROPE TO YOU • SEND YOUR NAME AND ADDRESS AND WE'LL SEND YOU FREE SAMPLES OF EACH SIZE AND COMPLETE ORDERING INFORMATION.

In Australia contact
 ATN Antennas, Birchup, Victoria

synthetic textiles, inc. 2472 EASTMAN AVE., BUILDING 21
 VENTURA, CALIFORNIA 93003
 (805) 658-7903



179

ham radio TECHNIQUES

Bill W6SAI

that golden day

Some readers may remember my April column, wherein I mentioned the "black hole" in Amateur Radio, an area of western China between India and the USSR. Known as Xinjiang Province — and void of Radio Amateur activity — it measures some 600 miles in diameter.

But now BY0AA was rumored to be active in Ulumqui! One afternoon around 0100Z, I was tuning around 14,127 kHz when I heard a weak, watery signal working a UA9 station. Could this be . . . ? I closed my eyes — all good DXers know you can hear a weak signal better with your eyes closed — YES! The signal signed BY0AA. This was my chance. No one else was calling . . . the frequency was clear. To avoid alerting the competition, I gave a quick one-by-two: BY0AA DE W6SAI W6SAI K.

The room filled with a golden light. I heard the BY come back to me, but my mind slipped back to the early days of DX when I was a high school lad. The goal of active DXers then was to achieve the near-impossible: WAC (Worked All Continents) on phone!

It wasn't hard from the west coast, because a few Asians were on phone, but their signals never seemed to filter through to the New York area. True, a few DX giants such as W2AZ, W2HUQ, W2IXY, and W4DLH had done the impossible, but never a greenhorn kid running 120 watts into a dipole.

And then on that long-ago golden day, when the big DXers must have been asleep, I worked VU2CQ in Bombay, India on phone. It was truly a shattering experience and one not repeated until I had the thrill of work-

ing a station in the elusive "black hole" — Xinjiang province, formerly known as Chinese Turkestan!

Other DXers share the same exciting experience. The *1986 Top Band Annual News Digest* edited by Ivan Payne, VE3INQ, is a revelation. Armed with a good antenna, sufficient power, stamina, and an urge to excel, a group of 160-meter DXers are turning the top band into a replica of 20 meters! According to Ivan's DX log, W8LRL has 203 countries on 160, followed by N4PN and VE1ZZ with 184 and 189, respectively. And G3SZA and PA0HIP both have 39 zones on 160 meters! Now that's real DX!

a wideband 80-meter antenna

The wideband 80-meter antenna is still an elusive concept. The best way of doing the job is to make a "fat" dipole. Some of these designs have been shown in earlier columns. I recently received a note from Frank Geisler, W7IS, who had built various "fat" cage antennas for 80-meter operation. They seemed to work after a fashion, but they were large and unwieldy. They were easy to tangle up during erection and had heavy wind loading.

Searching for a better solution, Frank came up with the antenna shown in fig. 1. Very simple, it consists of five dipoles connected in parallel. The complete antenna is only 114 feet long. The short dipoles have a 2-foot separation so that overall spread of the wires is 10 feet. This interesting antenna is easy to get up in the air because only one wire is erected at a time. The top wire is pulled up first, then the other wires are added,

one at a time, from top to bottom. Frank used No. 18 wire and cut all the dipoles to the same length. The operating bandwidth is sufficient to cover the range of 3.5 to 4.0 MHz with an SWR of less than 2:1.

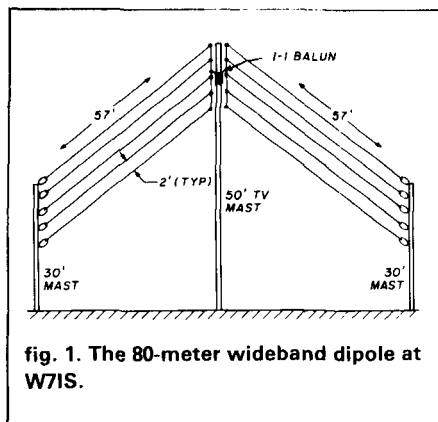


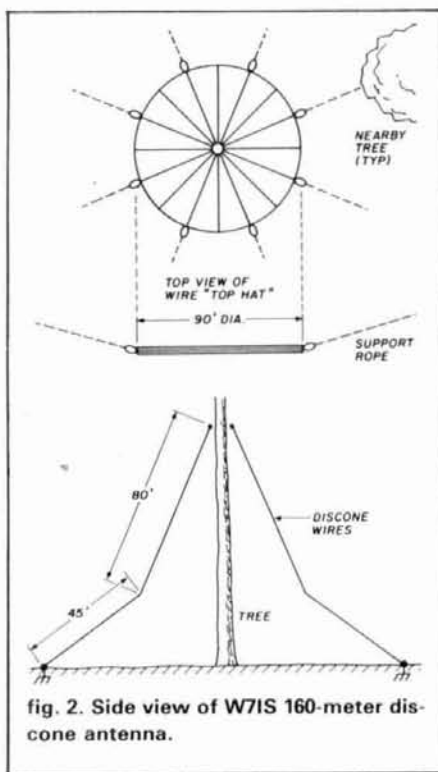
fig. 1. The 80-meter wideband dipole at W7IS.

No spreaders are necessary in this simple antenna. The wires have never tangled — not even in 60-mph winds. The wires attach separately to the center mast and are connected together with a short length of wire. A 1:1 balun is used to match a coax line.

Next, Frank wants to try reducing the number of wires to three, separated by 4 feet. It will be interesting to see if he can maintain operating bandwidth with fewer wires.

a 160-meter discone antenna

W7IS is a stalwart experimenter. He had always wanted to try a discone antenna for 160 meters to achieve vertical polarization with good operating bandwidth (see fig. 2). The top disc was assembled from wire and was 90 feet in diameter! The disc was pre-assembled on the ground and hauled



into position at the 80-foot level! He used nylon ropes to steady the assembly. The ropes ran to seven nearby trees. Pulleys and weights on each of the ropes allowed the top disc to flex in the wind.

The center support tree was 80 feet high and the discone wires were 130 feet long. The cone wires dropped down to the 10-foot level and then were run along the ground at this level for 45 feet. The natural resonance of the antenna turned out to be 2.1 MHz, so an antenna tuner was used to reach 1.8 MHz.

The last step was to ground the end of each discone wire with an 8-foot rod. All ground rods were tied together. This lowered the resonant frequency of the antenna to 1.8 MHz and dropped the SWR to less than 3:1 over the range of 1.8 to 7 MHz.

Frank states this was a major construction project that required large

amounts of No. 12 wire. The antenna has been up for three years and is still in use. He says the antenna is good for DX and illustrates how much better vertical, rather than horizontal, polarization is on 160 meters.

For a simple 160-meter DX antenna, Frank says it's very hard to beat a simple dipole about 80 feet high. The discone is a better antenna, but it's difficult to construct, takes up a lot of wire, and requires plenty of real estate!

the 160-meter beam at PY1RO

The robust signal of Rolf, PY1RO, is well known to all 160-meter DX operators. He's tried various antennas and says that the array shown in **fig. 3** is one of the best. Suspended from a 230-foot tower, the array consists of six half-wave (quad style) loops, equally spaced around the tower. They use two half-loops as a director, two more

To transform your shack into a DX powerhouse, combine the intelligence of Yaesu's FT-767GX HF/VHF/UHF base station and the muscle of our powerful FL-7000 HF amplifier.

You'll be amazed at how you can cut through pile-ups. Be heard anywhere in the world. And wake up other wise inactive bands.

The brains of the operation: The FT-767GX. This intelligent HF/VHF/UHF base station includes four microprocessors for unparalleled flexibility and ease of operation.

Features include 160 to 10 meter transmit, including WARC bands. Optional plug-in modules for 6-meter, 2-meter and 70-cm operation. Receiver coverage from 100 kHz to 30 MHz. AM, FM, SSB, CW, AFSK modes built in. Ten memories that store frequency, mode, and CTCSS information (optional CTCSS unit for controlled-access repeaters). Memory check feature for checking memory status without affecting operating frequency. Dual VFOs with one-touch split frequency capability. VFO tracking for slaved VFO-A/VFO-B operation at a constant offset. Digital display in

10 Hz steps. Slow/fast main dial tuning. Synthesizer step programming at up to 99.99 kHz per step. Digital SWR meter. Digital RF power meter. Built-in RF preamplifier. Adjustable drive level from 0 to 100 watts. Blue fluorescent display. Built-in AC power supply.

Up to 30 minutes continuous transmit (100% duty cycle). Full CW break-in. Built-in CW electronic keyer. Audio peak filter for CW (Yaesu patent). CW and AM wide/narrow filters. Woodpecker noise blanker.

RF clipping speech processor. IF shift for both receive and transmit (TX side allows you to adjust voice frequency response pattern). IF monitor. IF notch filter. Audio low-pass filter.

Built-in antenna tuner with memory of settings on each band. Separate antenna connectors for each VHF or UHF optional unit. Separate beverage antenna receive input on rear panel. Quick turnaround time from TX to RX for AMTOR, Packet, and QSK CW. AGC slow/medium/fast/off selection. Push-pull MRF422 transistors



GET THE BRAINS.

half-loops as reflectors, and the remaining loops as a "fat" radiator. The loops are electrically switched in six different directions. Polarization is vertical and a front-to-back ratio of better than 10 dB is noted. Front-to-side ratio is about 15 dB.

The switch box is located at the 16-foot level. Because each of the loops is self-resonant at 1925 kHz, they act as "natural" directors at the low frequency end of the band. The relays add sufficient length to the loops to make them resonant at 1740 kHz to act as reflectors.

Rolf notes that the high tower is a natural attraction for lightning. During a recent storm, he had two direct hits on the tower in the space of two hours. The installation is protected by a lightning arrester (charge dissipator, or lightning rod) at the top and by six grounds at the bottom. Unfortunately, the coax from tower to station was left

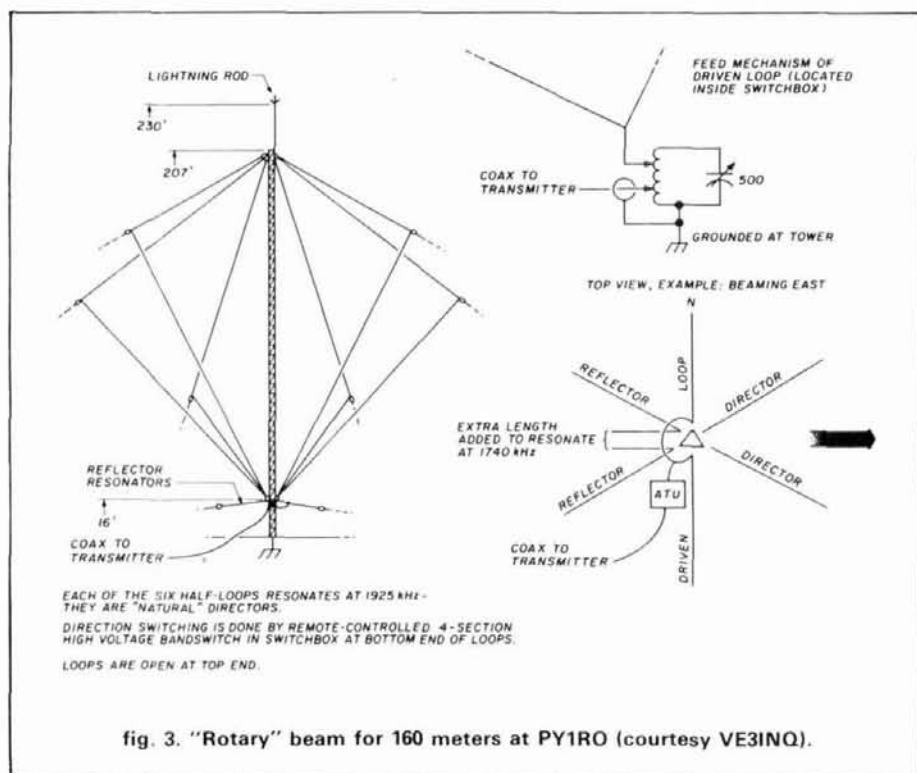


fig. 3. "Rotary" beam for 160 meters at PY1RO (courtesy VE3INQ).



AND THE BRAWN.

(rated dissipation 290 watts each) operated at 24 volts for excellent intermodulation rejection in transmitter.

Enhanced C.A.T. system for external control of transceiver from personal computer. (Software for Apple IIe/MAC, Commodore C-64, and IBM-PC is available through your Yaesu dealer.) There's also data communication with the FL-7000 linear amplifier for hands-free amplifier operation.

The muscle to get you out: The FL-7000. This solid-state amplifier covers 160 to 15 meters, and includes

a built-in power supply, automatic tuner and lots of powerful operating features.

There's fast turnaround time for break-in (QSK) CW, HF packet radio, and AMTOR. Only 70 watts excitation for full output, and 1200 watts PEP input power. Fully protected push-pull parallel wideband "no-tune" amplifier circuit powered by 47V, 25A DC power supply. Yaesu's exclusive "DVC" (Direct Vertical Cooling Heatsink System) with bottom-mounted fan. Automatic antenna matching sensor

turns off amplifier and rematches tuner circuitry if SWR rises above 2:1. Hands-free automatic band change when used with FT-767GX, FT-757GX or FT-980. Lithium battery backup remembers antenna selection and tuner settings. Dual 2-speed fans with independent thermal sensors. Connection to up to four antennas, including automatic selection via optional unit. Eight front panel LED status indicators. And more.

Get the DX advantage. Just combine the FT-767GX's brains, the FL-7000's brawn, and your special operating knowledge. What an impact you'll make on the world!

YAESU

Yaesu USA

17210 Edwards Road, Cerritos, CA 90701
(213) 404-2700

Repair Service: (213) 404-4884

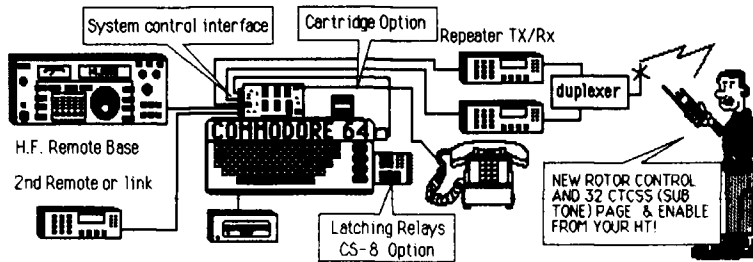
Parts: (213) 404-4847

Yaesu Cincinnati Service Center

9070 Gold Park Drive, Hamilton, OH 45011
(513) 874-3100

Prices and specifications subject to change without notice.

New Features **Super ComShack 64** More Advanced controls!
Repeater Controller/Dual Remote/Autopatch/Shack Control



Super Repeater Controller

- *Remotely programmable with Touchtones/change up to 9 parameter sets from H.T. or telephone!
- *Synthesized speech; high quality natural sounding human male or female voice
- *Dual Remote base/ Control freq/mode/scan/on/off
- *Autopatch fast access & speed dial tone or pulse
- *Program voice ID message/courtesy beep from H.T.
- *Automatic voice clock & user programmable timers
- *Multiple commands can be executed at once (up to 22 digits per command string)
- *CTCSS tone paging/voice paging/8 relay cont. opt.
- *Alarm clock & auto-excute command string!
- *Optional autoboot cartridge (no disk drive needed)
- *Send control commands from any telephone!

Special Club Features

- *Generates random code practice @ any speed with voice readback after each 20 random code group!
- *Set CW speed/pitch/courtesy beep from your H.T.
- *Input up to 22 vocab words & letters as ID or mail box message @ speed dial rates from H.T.
- *Easy to maintain C64 computer/ low cost repair!

Autopatch Specifications

- *300 Touchtone/parameter loadable autodial numbers, inc: 10 Emergency (quick access)
- *300 Reverse patch call signs voice paged with CTCSS activated/general & directed page modes
- *Incoming caller receives voice message to enter 3 digit code to selective page a call sign (D.P. mode)
- *Two autopatch access codes-Hi/Low priority access
- *Enable/disable 50 number strings + wild card #'s
- *Full or half duplex (repeater on/off); TT muted
- *Storage of MCI/Sprint access codes+delay digits
- *Call waiting allows switching to second call
- *Touchtones are regenerated onto the tel./speed dial
- *CTCSS paging group/ individual or reverse patch
- *Reverse patch active in all modes

Dual Remote Base Specifications

- *H.F. CAT remote: Yaesu FT-757/767/980 Kenwood TS-440/940, Icom IC-735
- *2nd remote: Yaesu FT-727/FT-767 (UHF & VHF); Kenwood 811/711 - serial data ... or use 7950 TS-2530/70 with RAP1 (row & col. control card.)
- *10 H.F. Memory channels/enter or recall
- *Automatic USB/LSB/FM/AM mode select
- *Scan up/down, fast, slow or 100hz steps
- *Control CS-8 relay/latch /master reset /Status
- *H.F. / 2nd remote: Monitor only; or TX enable modes
- *All control inputs are voice confirmed including frequency, mode, scan status, time, outputs on/off
- *VHF remote, as link input, & repeater can be active

System Options

- *8 Latching Relay control; Model CS-8.....\$79.95
- + 3 DPDT 2A relays, 5 open collector outputs
- + user defined 2 letter function name & state
- + automatic PTT fan control/master all off code
- + CTCSS group call/individual (HT programmable)
- + Ham "M" rotor interface Model HM-1...\$49.95
- *Optional CMOS auto-boot 72k EPROM Cartridge programmed with your parameters\$99.95
- *Keypad Control for VHF remote, RAP 1...\$149.95
- *Super ComShack Manual (credit later) ...\$15.00

MODEL CS64S-\$349.95 (wired and tested)

includes: computer interface, disk, cables & manual, use with: C-64/C-64C/C-128/SX-64 (spec. inst.)

Commercial version also available

(add \$4.00 shipping / Ca. residents add 6%)

MASTERCARD/VISA/CHECK/M.O./COD

Engineering Consulting
 583 Candlewood St.
 Brea, Ca. 92621
 tel: 714-671-2009

connected during the storm. His station suffered extensive damage, including charred connectors, outlets, and wire all the way back to the circuit breaker box! Now, all wires to the tower are disconnected during a storm!

a one-chip, dual-conversion fm receiver!

Interested in an ultra-compact VHF fm receiver? Motorola has just announced the MC3362 bipolar analog IC, which comprises a single-chip receiver from antenna input to audio amplifier output. Useful from 50 to 150 MHz, the device provides excellent sensitivity and good image rejection in narrowband voice and data link applications.

The MC3362 was featured at the recent RF Expo East as a single-chip receiver operating in the 2-meter band (144.585 MHz) and drew crowds of interested Amateurs and engineers! For more information on this formidable device, contact Motorola, Inc., Bipolar Analog IC Division, Tempe, Arizona 85200.

new EME directories

A new supply of the popular "144 MHz EME Directory" has been printed. This lists many of the moonbounce stations and operators, giving the name, call, address, phone number (where applicable), and equipment. To obtain your copy, send five first-class stamps (or five IRCs) to me at EIMAC, 301 Industrial Way, San Carlos, California 94070.

ham radio

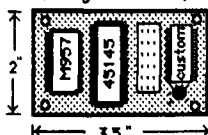
Audio Blaster IC-02/04 AT;2AT;U16;FT209;FT727R

Module installs inside the radio in 15 Min. Boost audio to 1 watt! Low standby drain/Corrects low audio/1000's of happy users. Miniature audio amplifier-->



Used by Police, fire, Emergency, when it needs to be loud!
 Now available for **Yaesu FT-727R**
 Model AB1-\$19.95

Touchtone 4 Digit Decoder & on/off latch all 16 Digits/low power



Repeater on/off Master control

Wired and tested +5 to +12 Volts/ User programmable to 50,000 codes/ All 16 digits/Send code once to turn on, again to turn off/ Momentary & Latching output/drives relay/LED latch indicator /Optional 4 digit extra custom latch IC's \$8.95 each/add as many latches as you want to your external board. Model TSD \$59.95

Remote-A-Pad Two TSD's (above) and Row & Column control interface; all on one board, remote control of any 16 digit keypad with touchtones. Simple stand alone control card. Wired and tested. Model RAP \$149.95

Touchtone Decoder Kit M957 Teletone, +5 to 12v. 15ma/inc 3.58 Mhz Crystal/ 22 pin socket, Data Sheet, Sample circuits, decoder specs, all 16 TT; BCD/HEX out. Model TTK \$22.95



Touchtone to RS-232 (300 baud interface)

Program your computer in basic to decode multidigit "strings", sound alarms, observe codes. Simple to install, includes basic program for C64/VIC20/C128, works with all computers!
"DECODE-A-PAD" Model DAP \$89.95

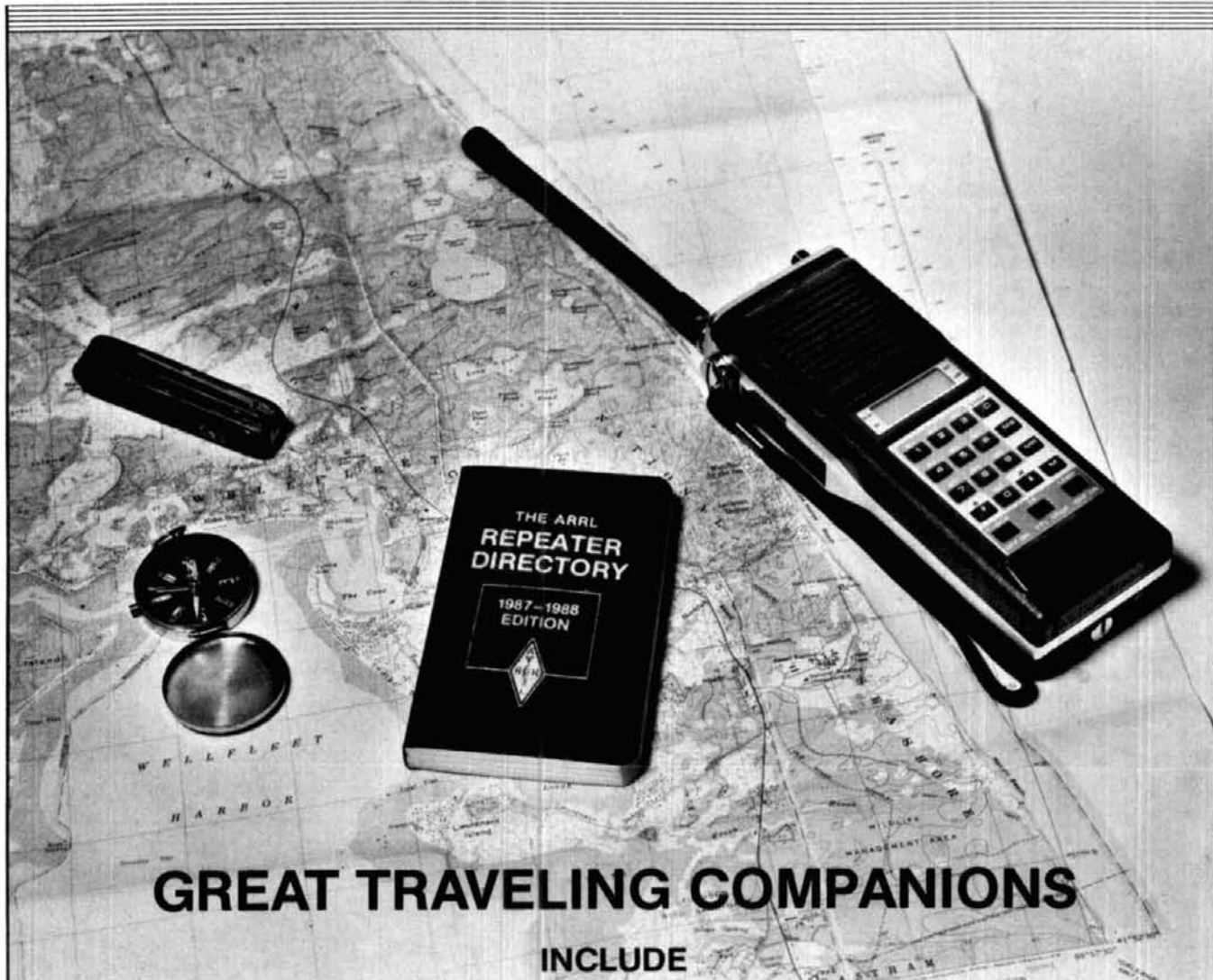
MINI (BEAR) CAT SCANS & PROGRAMS FT-727R

- *Scans up to 100 channels at once by sending freq data to the radio
- *Program digital "S" meter; scan stops from S(1-9); Auto resume
- *Program 100 channels; including offsets, subtones, TX,RX, & all FT-727R keyboard commands. Save all sets to disk & print out
- *Loads & programs all FT-727R parameters in less than 15 seconds.



- *Includes hardware interface and disk for the C-64
- *Scan lock out, set scan delay
- *General or Ham coverage modes
- *User friendly, easy to assemble interface includes connectors

NEW!
MODEL 727S \$39.95



GREAT TRAVELING COMPANIONS

INCLUDE

THE ARRL 1987-1988 REPEATER DIRECTORY! OVER 12,000 LISTINGS

Novices will find the 220 and 1270 MHz listings a must. For those interested in packet radio and other modes there are almost 1,000 digipeaters and specialized repeaters listed. You'll find much other useful information including a CTCSS (PL) Tone Frequency Chart, addresses of members of both the ARRL VHF-UHF and Repeater Advisory committees, band plans, information on how to operate through repeaters, compilations of frequency coordinators and ARRL Special Service Clubs. Available in the handy pocket-size (3¼ x 5¼ in.) that was introduced last year. 16th Edition, copyright 1987, \$4.00. Shipping and handling \$2.50 (\$3.50 for UPS). Off the press in late April. Purchase at your dealer or directly from:

The American Radio Relay League, Inc.
225 Main Street, Newington, CT 06111

PRACTICALLY SPEAKING ...

JOE Carr
K4IPV

battery problems: part 1

As its title states, this column covers the practical aspects of Amateur Radio. Yet because much of my electronic servicing career has involved working with non-Amateur applications, it would seem to make sense to share some of the results of that experience with you here, since the principles addressed apply to Amateur Radio as well.

As I've mentioned before, I spent several years working in biomedical electronics at a large university medical center, where batteries were used for many different reasons. Some equipment was battery-powered for reasons of portability. A defibrillator, for example, might be needed anytime, anywhere . . . heart attacks don't always happen when patients are conveniently near electrical outlets or fixed-location machines. Although most of our defibrillators were ac- or dual-powered, we also had a number of purely battery-powered models.

We had battery-powered monitors used to keep track of ECG and blood pressure as patients were transferred between units — for example, from the Emergency Room to the Intensive Care Unit. Small VHF/UHF fm ECG telemetry transmitters kept track of ambulatory patients, and still other devices relied on battery power for reasons of patient safety. A cardiac output computer, for example, makes measurements based on a thermistor inserted into the heart. Because even minute amounts of ac "leakage" current could be fatal, batteries were used to completely isolate the instrument

from the ac power line. During those years I learned a few valuable lessons on the use of batteries in electronics equipment.

First, though, a note on terminology. In rigorous usage, a "cell" is the most basic element, and has the minimum voltage for that sort of device. We gain additional voltage by connecting the cells in series and extra current by connecting them in parallel. To be strict, we would refer to the single entities as "cells" and multiple-cell entities as "batteries." But in common usage — where it's usually acceptable to be less rigorous — all cells and batteries are called "batteries." We'll follow that practice here.

Portable medical electronics equipment is powered with NiCds. These batteries have a nominal terminal voltage, at full charge, of 1.2 volts, except immediately prior to turn-on after a fresh charge, at which time the open-terminal voltage is 1.4 volts. Sometime after turn-on, however, the open-terminal voltage drops to the nominal value of 1.2 volts for the duration of operation. As the stored energy is used up, however, the terminal voltage drops lower.

NiCds will normally sustain 1000 charge-discharge cycles before becoming unusable. Manufacturers typically rate a battery unusable when the capacity of the battery drops below 80 percent of its original specified value.

The capacity of a battery is measured in ampere-hours — that is, the product of the current load (in amperes) and the time required to reach the officially designated discharge state. The NiCd is capable of deliver-

ing some tremendous currents: for example, the D cell (4 A-H) and F cell (7 A-H) can deliver short duration currents of 50 amperes or more. (This is why they're used in defibrillators, and why portable Amateur Radio transmitters can use them.)

Because they deliver huge currents, NiCds should be fused in order to protect printed wiring tracks, wires, and other conductors. I've seen copper foil pc tracks and an on/off switch smoked by a shorted capacitor across the dc line from a NiCd battery.

The amount of time that a battery will sustain its charge is a function of the discharge time, which in turn is determined by the amount of current drawn.

Figure 1 shows two different discharge scenarios: one for a current of 1/10 the A-H rating, and one for a current equal to the A-H rate. In **fig. 1A**, the battery will be fully discharged in 10 hours, while in **fig. 1B** discharge will occur in 1 hour. This particular chart is derived from the data published for a D cell rated at 4 A-H.

The standard cell ratings for NiCds are as follows:

Battery Size	A-H Rating
AA	0.4/0.5/0.7
C	2
D	4
F	7

As you can see, the AA cells are available in three ratings from 400 to 700 mA-H, depending upon the manufacturer and style.

You'll find plenty of variation from this chart, especially among consumer product quality (rather than professional quality) NiCd batteries. I've seen

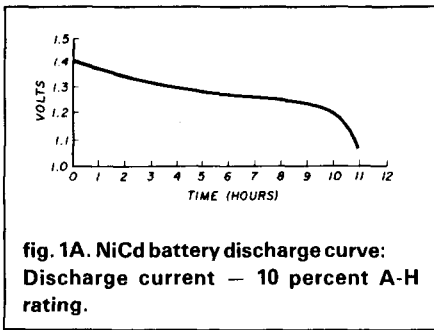


fig. 1A. NiCd battery discharge curve:
Discharge current — 10 percent A-H
rating.

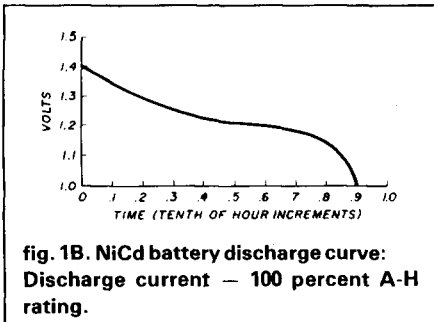


fig. 1B. NiCd battery discharge curve:
Discharge current — 100 percent A-H
rating.

C cells rated at both 1 and 1.2 A-H, and D cells rated at 2 A-H. I suspect that these are lesser cells dressed in C and D packages; one manufacturer's representative admitted to me that his consumer D cells were actually C cells inside of D packages!

This chicanery, of little consequence to most consumer electronics users, results in a lower cost product. But if you use these batteries in communications equipment, make sure that you get the correct A-H rating. It's been my experience that Gould brand cells are fully rated; others may require caution.

Some distributors play the rating game by quoting different discharge rates. One standard method of measuring A-H capacity is the amount of current required to discharge a cell to 1.0 volts in 1 hour. Some makers, however, define A-H capacity in terms of the 10-hour discharge rate normalized to ampere-hours. In analyzing figs. 1A and 1B, you can see how this might result in a warm, fuzzy — but false — feeling of capacity.

The charging protocol for NiCds depends some what on the application and manufacturer. In general, though, the charge current must be at least A-H/20, and in many commercial consu-

mer battery chargers it's often A-H/15. For most applications where you can control the charge rate, it's safe to use a charge rate of A-H/10. That is, charge the battery at a current not greater than 1/10 the ampere-hour rating. In addition, the battery must be charged to 140 percent of capacity, so a charge time of 14 hours is mandated. The general rule is: *charge at 1/10 ampere-hour rating for 14 hours.*

Some chargers are designed to fast-charge the battery in as little as 1 hour; most, however, demand 3 to 4 hours. Fast-charging should not be done unless the battery manufacturer recommends it. Even then, I'm a little cautious about fast-charging, having once seen a D cell explode during too-fast charging. NiCds can be dangerous, so follow the maker's recommendations carefully.

NiCds have finite shelf lives as well. Some users find that a battery charged, then stored, is unusable when it's eventually turned on. My old Wilson walkie-talkie suffered that fate several times. **Figure 2** shows a storage discharge curve for a typical NiCd. As you can see, the battery or cell will be of questionable utility after only a few weeks' storage. The cure for this problem is a trickle charge during long-term storage at a rate between A-H/30 and A-H/50. Some commercial battery chargers have a switch that allows either A-H/10 regular charge rate or a A-H/30 trickle charge.

Another problem with NiCds is operating temperature and its effects on available capacity. As shown in **fig. 3**, the available current capacity is a function of temperature. As the temperature increases above room temperature (72 F, 25 C), the available capacity diminishes. I'd like to see some data on NiCd performance at cold temperatures.

NiCd "memory"

You'll hear a running debate about whether or not NiCds have or do not have a memory problem. In this context, memory means that a battery

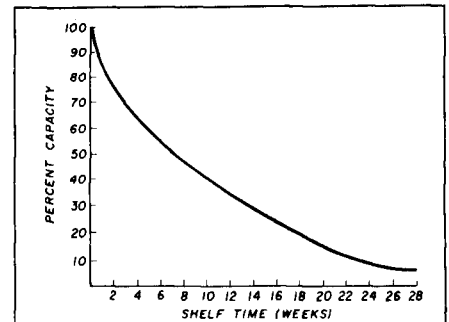


fig. 2. NiCds lose their charge even if unused.

won't allow deep discharge after repeated shallow discharges. For example, if a battery is repeatedly discharged in some particular application to only 80 percent of capacity, after a while it will "remember" the 80-percent level as the fully discharged point. The battery will then exhibit the fully discharged potential when the charge level is only 80 percent of fully charged. This makes the battery appear to have suffered premature failure. A NiCd battery with memory problems can sometimes be rehabilitated by repeatedly fully charging it, and then immediately deep-discharging it. Eventually the memory phenomenon should work itself out.

The best cure for the memory phenomenon is to avoid it. I have a friend who lives in constant pain, and as a result uses an electronic pulse generator called a "Transcutaneous Electronic Nerve Stimulator" (TENS) to keep the pain at a manageable low level. This physician-prescribed device runs on small NiCd batteries. When my friend complained that the \$90 battery pack lasted only a few weeks, I questioned him further and found that he routinely placed the TENS in the charger every night, even though he didn't use it all the time. The TENS battery was obviously being routinely shallow-cycled, and consequently had developed a memory. I advised my friend to keep two battery packs available: one in an insulated bag in his briefcase, for use when the other one goes dead, and the other in the TENS itself. When the TENS battery is low, my friend simply swaps battery packs.

He used one battery pack for two years, and had been averaging at least a year on each — instead of six weeks.

When equipment is subject to routine maintenance, it's possible to keep the batteries healthy by following a certain routine. In most of the equipment I've serviced over the years, the manufacturer recommended that the batteries be periodically discharged and then recharged. The protocol for most is as follows:

- Fully charge the battery or cell.
- Discharge it fully with a resistor that draws a current of A-H/10 for 8 to 9 hours for multi-cell batteries, and 10 hours for single cells.
- Recharge the battery at the A-H/10 rate for 14 to 16 hours.

If the battery is not fully discharged, a phenomenon called "polarity reversal" may occur because not all cells have the same terminal voltage at any given time. It might happen that one cell will become charged backwards by the others in the series chain. For this reason, multi-cell batteries are discharged to only about 10 to 20 percent of capacity.

When a unit uses multiple cells to achieve higher voltage levels — and it's possible to remove those cells individually — it's better to discharge and recharge them one by one.

Batteries left in a discharged condition for a lengthy period of time may develop inter-element shorts: little whiskers (called "dendrites") grow from plate to plate, causing a short circuit. The cell potential drops to zero or near-zero, and the cell refuses to accept a charge. In some cases, we would have to regard the cell as lost and replace it. There are, however, some cells that can be salvaged from short circuits.

Figure 4 shows a revitalization circuit for shorted NiCd cells that works by vaporizing the internal dendrites that short the plates together. A known-good cell of the same type is placed across the shorted cell through a push-button or spring-loaded toggle switch. (It's important to use this type of switch instead of a regular switch . . . we don't want to keep the circuit

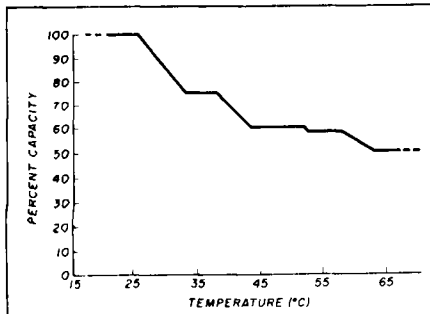


fig. 3. Elevated temperatures reduce NiCd performance.

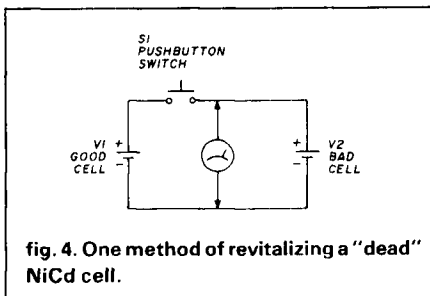


fig. 4. One method of revitalizing a "dead" NiCd cell.

closed for too long because an explosion could result.) Press the switch several times in succession, then measure the terminal voltage. If the current from V1 successfully vaporizes the dendrites inside V2, then the terminal voltage will rise.

CAUTION: wear safety goggles or glasses when performing this operation. NiCd batteries have been known to explode under high current, and it could conceivably happen when repairing a shorted cell. I've never seen it happen under these circumstances, but I wouldn't bet my eyesight on its never happening.

next month

In the final installment of this two-part series, we'll take a look at charging schemes for NiCd batteries. We'll also take a look at lead-acid and gel-cell batteries used to power mobile and portable Amateur equipment.

ham radio

SHORT CIRCUIT HOTLINE

Building a current ham radio project? Call the Short Circuit Hotline any time between 9 AM and Noon, or 1 to 3 PM — Eastern time — before you begin construction. We'll let you know of any changes or corrections that should be made to the article describing your project. (See "Publisher's Log," April, 1984, page 6, for details.)

603-878-1441

RF TRANSISTORS

See us in Atlanta

P/N	Rating	2.30 MHz 12V (1" 28V)	Net Ea.	Match Pr.
MRF412,IA	80W		\$18.00	\$45.00
MRF421	Q 100W		22.50	51.00
MRF422*	150W		38.00	82.00
MRF426,IA*	25W		18.00	42.00
MRF433	12.5W		12.00	30.00
MRF448,IA	Q 30W		12.50	30.00
MRF450,IA	Q 50W		14.00	31.00
MRF453,IA	Q 60W		15.00	35.00
MRF454,IA	Q 80W		15.00	34.00
MRF455,IA	Q 60W		12.00	28.00
MRF458	80W		20.00	46.00
MRF475	12W		3.00	9.00
MRF476	3W		2.75	8.00
MRF477	40W		11.00	25.00
MRF479	15W		10.00	23.00
MRF485*	15W		6.00	15.00
MRF492	Q 90W		16.75	37.50
SRF2072	Q 65W		13.00	30.00
SRF3862	Q 110W		25.00	54.00
SRF3775	Q 75W		14.00	32.00
SRF3795	Q 90W		16.50	37.00
3800	Q 100W		18.75	41.00
2SC2290	80W		19.75	45.50
2SC2879	Q 100W		25.00	56.00

Q = Selected High Gain Matched Quads Available

VHF/UHF TRANSISTORS				
P/N	Rating	MHz	Net Ea.	Match Pr.
MRF224	40W	136-174	13.50	32.00
MRF237	4W	136-174	3.00	—
MRF238	30W	136-174	13.00	30.00
MRF239	30W	136-174	15.00	35.00
MRF240,IA	40W	136-174	18.00	41.00
MRF245	80W	136-174	28.00	65.00
MRF247	75W	136-174	27.00	63.00
MRF807	1.75W	136-174	3.00	—
MRF641	15W	407-512	22.00	49.00
MRF644	25W	407-512	24.00	54.00
MRF646	40W	407-512	26.50	59.00
MRF648	60W	407-512	33.00	69.00
SD1441	150W	136-174	74.50	170.00
SD1447	100W	136-174	32.50	78.00
2N5591	25W	136-174	13.50	34.00
2N6080	4W	136-174	7.75	—
2N6081	15W	136-174	9.00	—
2N6082	25W	136-174	10.50	—
2N6083	30W	136-174	11.50	24.00
2N6084	40W	136-174	13.00	31.00

MISC. TRANSISTORS & MODULES				
P/N	Price	P/N	Price	
MRF134	\$16.00	MRF497	14.25	
MRF136	21.00	2N1522	10.50	
MRF136Y	70.00	2N3866	1.25	
MRF137	24.00	2N4048	10.50	
MRF138	35.00	2N4427	1.25	
MRF140	89.50	2N5590	10.00	
MRF148	35.00	2N5642	13.75	
MRF150	89.50	2N5643	15.00	
MRF172	82.00	2N5646	18.00	
MRF174	80.00	2N5945	10.00	
MRF208	11.50	2N5946	13.00	
MRF212	16.00	2SC2097	29.50	
MRF221	10.00	2SC2237	13.50	
MRF280	7.00	2SC1969	3.00	
MRF281	9.00	S10-12	13.50	
MRF282	9.00	SAV6	34.50	
MRF284	13.00	SAV7	34.50	
MRF406	14.50	SC1019	59.90	
MRF428	55.00	SC1027	47.50	
NE41137	3.50	M57737	47.50	

Selected, matched finals for Icom, Atlas, Yaesu, KLM, Kenwood, Cubic, TWC, etc. Technical assistance and cross-reference on CD, PT, SD, SRF and 2SC P/Ns.

Quantity parts users — call for quote

WE SHIP SAME DAY • C.O.D./VISA/MC

Minimum Order — Twenty Dollars

(619) 744-0728

FAX: (619) 744-1943

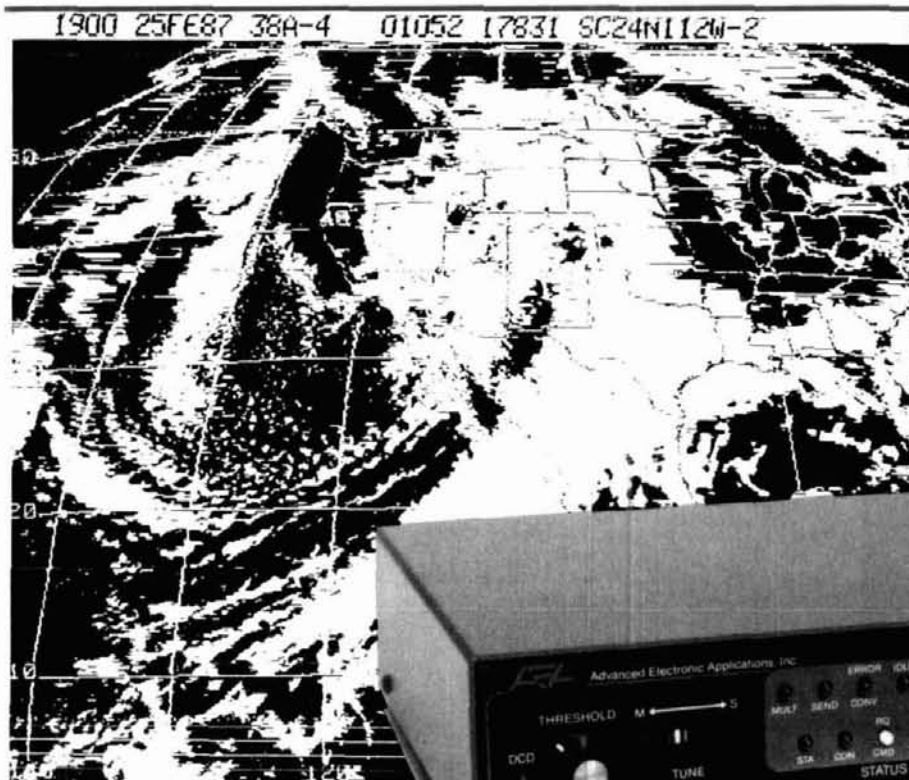


RF PARTS

1320 16 Grand Avenue
San Marcos, CA 92069

New PK-232 Breakthrough

Six Digital Modes - Including Weather FAX



A new software enhancement makes the AEA PK-232 the only amateur data controller to offer six transmit/receive modes in a single unit.

- * Morse Code
- * Baudot (RTTY)
- * ASCII
- * AMTOR
- * Packet
- * Weather FAX



\$319⁹⁵
AMATEUR NET
\$379.95 AEA RETAIL

Your home computer (or even a simple terminal) can be used for radio data communication in six different modes. Any RS-232 compatible computer or terminal can be connected directly to the PK-232, which interfaces with your transceiver. The only program needed is a simple terminal program, like those used with telephone modems, allowing the computer to be used as a data terminal. All signal processing, protocol, and decoding software is in ROM in the PK-232.

The PK-232 also includes a no compromise VHF/HF/CW modem with an eight pole bandpass filter, four pole discriminator, and 5 pole post detection low pass filter. Experienced HF Packeteers are reporting the PK-232 to have the best Packet modem available.

Operation of the PK-232 is a breeze, with twenty-one front panel indicators for constant

status and mode indication. The 240 page manual includes a "quick start" section for easy connection and complete documentation including schematics. Two identical back panel radio ports mean either your VHF or HF radio can be selected with a front panel switch. Other back panel connections include external modem disconnect, FSK and Scope Outputs, CW keying jacks, and RS-232 terminal interface.

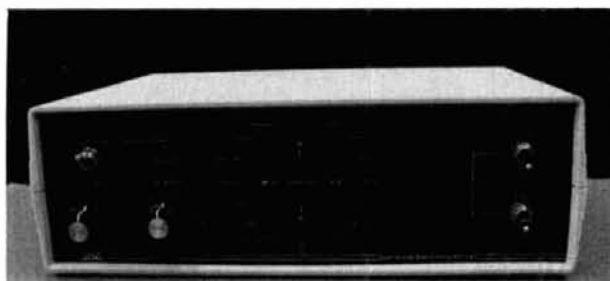
The RS-232 connector is also used for attaching any Epson graphics compatible parallel printer for printing Weather Fax. Weather maps and satellite photos, like the one in this ad, can be printed in your shack.

Contact your local AEA dealer today for more information about the one unit that gives you six modes for one low price, the PK-232.



Brings you the Breakthrough

2006-196th St. SW
Lynnwood, WA 98036
(206) 775-7373



an improved RDF

The Dick Smith Electronics (DSE) Model K-6345 Radio Direction Finder (RDF) unit* has drawn considerable interest among transmitter hunters. The low price of this kit, compared with the cost of other commercial Doppler RDFs, has been its main attraction.

The direction finder consists of two assemblies — a control/display electronics section and the ASU or Antenna Switching Unit. The display has an electronic compass, which is a series of 32 LEDs arranged in a circle whose illumination is a function of the transmitted signal arrival angle. The unit has potential applications from 6 meters to 70 cm for both sport and serious use in volunteer enforcement as well as search and rescue efforts. It's intended to work with any fm receiver in the appropriate frequency range, including handhelds and scanners.

problem areas

After evaluating the DSE unit and comparing it with similar homebrew and commercial Doppler RDFs, I found several shortcomings. Voice or tone modulation on the signal being hunted caused a "spreading" of the direction indication, frequently causing it to light all the LEDs in the circle on modulation peaks; getting a good bearing on a signal with continuous tone modulation was nearly impossible. Noise created by the electronic antenna rotation sometimes obliterated signals that were not full quieting, or spread the indication further. In addition, parasitic reradiation in the antenna system worsened the effects of multipath on the indication.

I found the original design virtually useless for mobile hunting in urban areas because the display dashed around rapidly with no discernible trend. Though the Doppler RDF technique is easier to use in motion than beam/quad/loop schemes — and also averages out multipath indications — this was not the case with the DSE unit because of the problems cited above.

*Available from Dick Smith Electronics, Redwood City, California for \$99.

By Joe Moell, K0OV, P.O. Box 2508, Fullerton, California 92633

Fortunately, there are several ways to improve the unit and make it a credible performer. Some of them have been mentioned briefly by the manufacturer in an addendum sheet now being supplied with the kit. I developed several others, including the fixes to the active filter stage described here. The modifications, all quite simple and involving little additional cost, are made in two areas, the Antenna Switching Unit (ASU) and the bandpass filter stage.

The instruction manual discusses the theory of how the Doppler effect is used for direction finding, but it gives no advice on how to install and use a Doppler RDF on a vehicle. Some practical hints on that topic are included later in this article.

the antenna unit

Electronic rotation of the antenna assembly is achieved by sequentially switching each of the four whip antennas to the receiver by the ASU. *Only one antenna is connected to the receiver at any one time.* The other three are disconnected by diodes D201-D204* in the ASU and shorted to ground by diodes D205-D208 at the antenna bases. Because these unused whips are grounded, they affect system performance by adding undesirable harmonic content and amplitude modulation to the induced Doppler signal. The effects of reflections from nearby terrain features are magnified by the reradiation. So even a small amount of multipath results in unreadable displays when the unit is used in motion.

The solution is to have the switched-off whips be electrically floating instead of grounded. Remove and discard the shunt diodes (D205-D208) at the bases of the four whips. Doing this won't adversely affect the operation of the ASU. There is 26 dB isolation from each switched-off whip base to the receiver using the shunt diode and 23 dB without it. The difference is insignificant.

The switched-off whips will still appear to be grounded if the coax lines to the ASU are an odd multiple of an electrical quarter wavelength. That's because a nonconducting diode in the ASU is trans-

*Component designations indicated are as used in K-6345 RDF kit and differ from customary *HR* nomenclature.

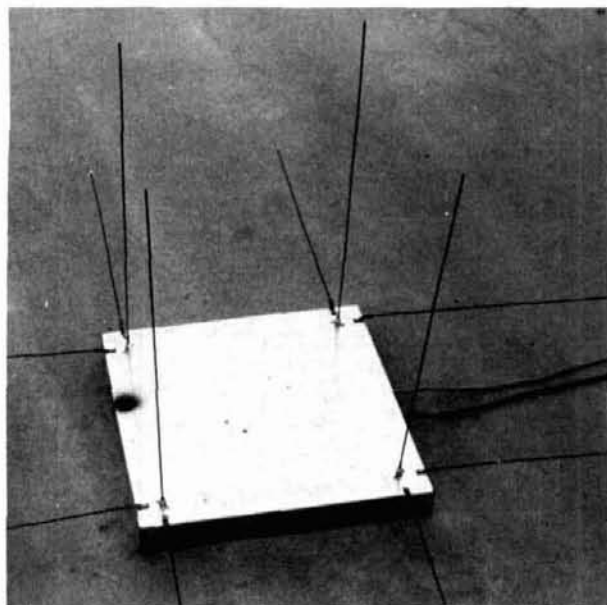


fig. 1. This antenna system is built in an aluminum chassis and uses bronze welding rod for elements. RCA phono plugs and jacks are used to attach the whips.

formed to an apparent short at the end of an odd quarter wavelength multiple line. For best results, change these lines to be exact electrical half wavelengths at the frequency of interest.

Be sure to take the velocity factor of the coax into consideration in the computation. For 2 meters, using ordinary polyethylene dielectric RG-58 (with a 66 percent velocity factor), the coax lengths should be 26-1/2 inches (or a multiple of that) from the antenna base to the ASU circuit board. This length includes the connector on the box and the coax from the connector to the board. For foam dielectric cables such as RG-8/X (with a 78 percent velocity factor), the length should be 31-1/2 inches for 2 meters. It's important that all four lines be of equal electrical length.

A one-piece antenna assembly like the one shown in fig. 1 is easy to mount on the roof of a car with suction cups and nylon straps (not shown). Use an all-metal enclosure, such as an aluminum chassis and cover plate. The plastic ASU box supplied by DSE is acceptable if it's placed inside a larger metal enclosure like the one shown.

Other ways to configure the antenna system include setting an open wooden frame with individual ground planes in the back of a pickup, mounting a set of four vertical dipoles on a PVC pipe support, or using four individual mag-mount antennas on the vehicle roof. In any of these cases, the ASU board should be placed either inside a metal box or inside a plastic box that has been sprayed with conductive paint for shielding.

The short leads inside the ASU box from the four coax receptacles to the board should be changed to

equal lengths of small coax, such as RG-174/U, replacing the bare wire provided. Alternatively, when the entire antenna system is housed in a metal enclosure such as shown in fig. 1, the four connectors can be deleted and the RG-58 lines can go directly from the antenna bases to the ASU board.

A good ground plane for the antenna system is very important. Eight radials are attached to the antenna base chassis with lugs as shown in fig. 1. The radials and the whips should be stiff enough that they don't flop around when in motion. Bronze welding rod (3/32 inch diameter) is ideal for this purpose; it accepts solder readily and is available inexpensively at welding supply stores.

Switching noise from the BA244 diodes supplied by DSE is objectionable because it can mask weaker signals. You'll notice an improvement by replacing D101-D104 with PIN types, such as Motorola MPN-3401. An equivalent part is available in the ECG and NTE replacement semiconductor lines as ECG-555

what is direction finding?

The classical method of direction finding employs a rotatable antenna and a receiver. Depending upon the antenna pattern and the detection method, the antenna is *slowly* rotated until either a maximum or minimum signal is detected.

Each antenna and receiver comprises one station. Two or three stations working from different locations are then able to compare bearings and determine an approximate location of the source. This process is known as triangulation.

A second method known as Doppler RDF uses a *rapidly* rotating antenna that in addition to receiving the main signal, introduces an fm component that is proportional to its speed of rotation. For example, as the antenna approaches the source, the frequency increases. As it rotates away from the source, the frequency decreases slightly. This is similar to the effect noticed as a train, with horn blaring, draws nearer. The tone rises and then diminishes. Note, however, that it's the phase — not the actual frequency of the tone — that contains information about the direction of arrival of the transmitted signal.

Instead of physically rotating the receiving antenna(s), an electronic switching method can be employed that in effect rotates the pattern and accomplishes the same purpose without moving parts. Practical Doppler RDFs sequentially switch four or more elements to simulate the single rotating antenna. Sometimes this technique is known as "pseudo-doppler."

and NTE-555. These diodes are in low-inductance packages with tabs instead of wire leads, and should be surface-mounted to the etch side of the ASU board, as shown in **fig. 2**.

optimizing the filter

The reason for "spreading" of the indication with modulation lies in the filter section. First of all, the Q of the switched capacitor filter section is set to 15 by the resistor values. This is far too low, giving poor voice rejection and a response time that is too rapid. Second, the peak in the filter response doesn't occur at exactly the detected Doppler tone frequency.

In a properly designed switched capacitor bandpass filter, the response peak is at an exact submultiple of the clock frequency. The filter peak should follow the clock input exactly, so that any drift in the antenna rotation frequency is tracked by the filter. Due to a characteristic of the MF5* filter IC, the peak will be offset by 0.615 percent if the two 10-k resistors (R16 and R17) are perfectly matched.

Such a good resistor value match is unlikely with the 5 percent resistors supplied. With unmatched resistors, the offset could be up to 10 percent. In the case of the evaluation unit, it was 7.1 percent. Any offset causes phase changes in the filtered Doppler signal when voice modulation and multipath cause amplitude changes in the input tone level. These phase changes result in erroneous changes in bearing on the RDF display.

Fortunately, it's easy to make significant improvements in the filter section. **Figure 3** shows the modifications and **fig. 4** indicates parts locations. First, raise the value of R12 from 150k to 2.7 megohms. This gives a filter Q of 270. Next, correct the offset problem by making the resistance at R17 0.615 percent (about 61.5 ohms) greater than R16.

Although it's possible to do this by choosing fixed resistors with a precision ohmmeter, there's an easier way that makes use of the greatly increased Q of the filter. Add a 1000-ohm variable resistor in series with R17. Since its adjustment is a bit touchy, a multiturn miniature trimpot is best. Glue it to the circuit board and wire it in; it will become a permanent part of the unit. Set the pot for zero ohms at first.

The pot is adjusted with the control unit hooked up to a completed antenna unit and VHF-fm receiver. Transmit an unmodulated test signal (from a separate transmitter) and measure the filtered df tone at pin 1 of IC5 (the MF5) with an oscilloscope or ac voltmeter.

If an ac voltmeter is used, put a 0.1 μ F capacitor in series with the meter lead to prevent the dc level at pin 1 from obscuring the filtered df tone.

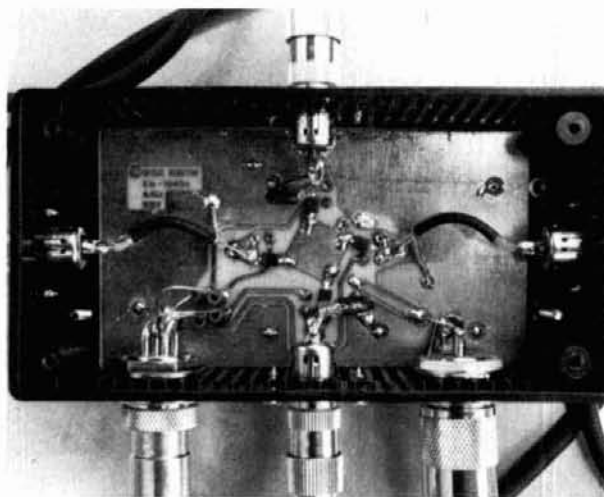


fig. 2. Interior of the ASU enclosure showing the equal length RG-174/U coax jumpers and NTE-555 PIN diodes, which replace the BA244s.

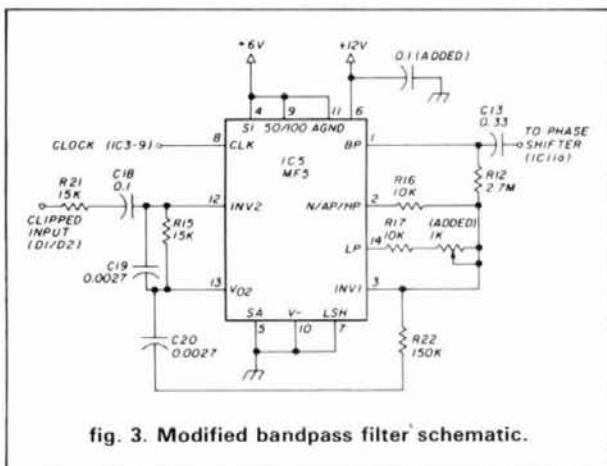


fig. 3. Modified bandpass filter schematic.

Slowly adjust the pot for maximum amplitude of this df tone. The test signal must be unmodulated and full quieting or it will be difficult to find the peak. The setting of the pot will depend on how well matched R16 and R17 are. If the level goes down instead of up as the pot resistance is increased, then R17 is already more than 62 ohms higher than R16. In that case, swap resistors at R16 and R17, set the pot to zero ohms, and try readjusting again.

It's important to mention that the Doppler tone into the control unit does *not* vary in frequency. Doppler shift introduces instantaneous change in frequency of the received rf signal, causing a tone to come out of the receiver's discriminator in addition to any other fm modulation on the signal (voice, for example). The phase of this tone is important — not the frequency, which is the same as the antenna rotation frequency. If the tone changes in frequency, it's because the

*This is a National Semiconductor part number. For more information, see the data sheet for the MF10, which is two identical MF5-type filters in one package.

WELCOME—
NOVICES

Call for Special
Prices on
220 MHz
Radios &
Antennas

MA. ★

TEL-COM★

Electronic Communications

NEW ENGLAND'S FACTORY-
AUTHORIZED SALES & SERVICE

FOR

KENWOOD



ICOM

Also displaying the popular accessories needed to complete a HAM STATION . . .

- ARRL PUBLICATIONS • AEA PRODUCTS • AMPHENOL
- ALPHA DELTA • ASTRON • AUSTIN ANTENNAS • AVANTI
- BELDEN • BENCHER • B & W • DAIWA • ALINCO
- HUSTLER • KLM • LARSEN • MIRAGE • ROHN
- TELEX/HY-GAIN • TOKYO HY-POWER LABS
- TRAC KEYS • VIBROPLEX • WELZ • ETC.

✓ 188

SONY

Models 2010 & 2002

RECEIVERS

\$329.00 & \$249.00

OPEN SIX DAYS A WEEK

Telephone 617/486-3400, 3040

675 Great Rd., (Rte. 119) Littleton, MA 01460

1/4 miles from Rte. 495 (Exit 31) toward Groton, Mass.

COMING SOON 1987-88 ARRL Repeater Directory

\$5.00 postpaid from ham radio Bookstore
Greenville, NH 03048 (603) 878-1441



VHF-UHF POWER DIVIDERS



RF power dividers provides the best way to lead in-phase 2 and 4 antenna arrays to maximize system gain and at the same time reduce losses to a minimum. Covering 144 thru 1296 MHz, this series of VHF/UHF power dividers are premier RF devices designed for a long service life with low SWR and broad operating bandwidth.

Extruded aluminum body with a durable enamel finish in addition to silicon sealing at connector flanges results in a ruggedized unit for all array installations. Available with N-type connectors only, these units are unconditionally guaranteed for 2 years.

MODEL	CONFIG.	PRICE
144-2P	(2 ports)	\$51.00
144-4P	(4 ports)	\$58.00
220-2P	(2 ports)	\$50.00
220-4P	(4 ports)	\$57.00
430-2P	(2 ports)	\$48.00
430-4P	(4 ports)	\$56.00
902-2P	(2 ports)	\$48.00
902-4P	(4 ports)	\$56.00
1296-2P	(2 ports)	\$49.00
1296-4P	(4 ports)	\$57.00

SHIPPING NOT INCLUDED

STRIDSBURG ENGINEERING, CO.

P.O. Box 7973 • Shreveport, LA 71107 • USA
Phone: (318) 865-0523

✓ 189

UP AND DOWN REPEATER LEVELS?

USE THE AGC-4 FOR REPEATER
OR OTHER AUDIO APPLICATIONS SUCH AS

- TRANSMITTER COMPRESSION
- PHONE / AUTO PATCHES
- PSEUDO PHONE LINE EQUALIZATION
- PRECEDING DTMF / RTTY / SSTV / PACKET DECODERS
- BROADCAST / RECORDING
- ANYWHERE CONSTANT AUDIO LEVELS ARE REQUIRED!



- DYNAMIC RANGE 20 DB
- OUTPUT LIMITATION LESS THAN 2 DB
- THD < 1%
- FREQUENCY RESPONSE 50 Hz TO 15 kHz
- OPERATING VOLTAGE 9 VDC
- OPERATING CURRENT 13 mA
- SIZE 1.825 x 2.75 x 1.25 IN (42 x 70 x 32 MM)

THE AGC-4 KIT AS FEATURED IN THE SEPTEMBER 1984
HAM RADIO

ONLY \$28.00 (POST PAID IN THE US AND CANADA)

FROM
BARRETT ELECTRONICS
525 N. 2150 W.
WEST POINT, UTAH 84015

✓ 190



SAVE YOUR EARS

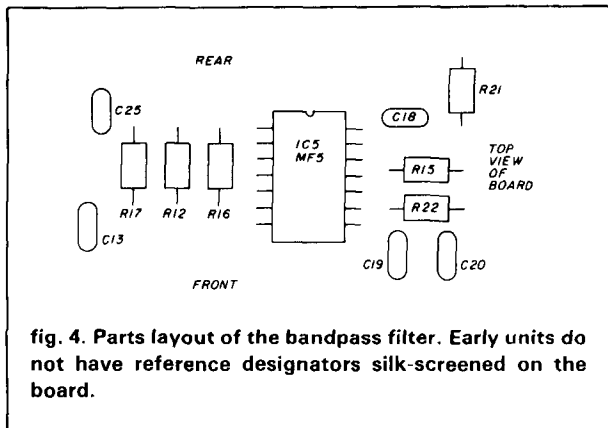
WITH THIS HANDY
SIGNAL ENHANCER

See Article in HR's
December, 1986 issue

Hildreth Engineering

936 Azalea Drive Sunnyvale, CA 94086

✓ 191



master oscillator (IC2) drifts. That's why a switched capacitor bandpass filter is ideal for this application. When driven from the same clock, it tracks.

To improve digital noise rejection and minimize the chance of oscillation, filter the Vcc line to the MF5 with a 0.1- μ F miniature ceramic capacitor. Put it on the etch side of the board at pins 6 and 7 with very short leads.

Increasing the value of R12 to 2.7 megohms provides high *Q* filtering without detrimental effects from clipping in the filter or phase shifter stages. Although unlikely, it's possible that such a high value on some units might upset the MF5 output biasing due to its input offset currents. It could also cause the MF5 to oscillate. If either occurs, lower the value of R12 as required. There were no such problems in my evaluation unit over a wide temperature range. The dc voltage at pins 1 and 14 of the MF5 with no Doppler signal input will be within ± 1 volt of the dc voltage at pin 11 if all is well.

checkout

Be very careful to confirm that the antenna is electronically rotating in the proper direction. It's easy to get it "backwards" so that the antenna unit and the display rotation are in opposite directions. If the antenna unit is rotating backwards, the unit will have a left/right (90/270 degrees) reversal of bearings when calibrated on a reference signal in front of the vehicle (zero degrees). I have seen this mistake in two kit builders' units. The four-pin shielded control cable must be wired pin 1 to pin 1, pin 2 to pin 2, etc.

The DSE instruction manual does not show the exact wiring of the four-pin antenna control cable connectors, nor does it show how to check for proper antenna rotation. There are two ways to do this after the unit is completed. When the instructions tell you to connect control cable pins to test point A and observe the 0, 90, 180, and 270-degree LEDs, connect test point A to the whips themselves in succession, not the control cable pins. This verifies wiring of the antenna cables as well as the control unit and ASU.

Antennas are numbered 1 to 4 in clockwise order as viewed from the top of the antenna system.

You can also use an oscilloscope to observe that the control pulses proceed from antenna to antenna in clockwise order. Look at the waveform at each whip. It's low (-0.6 volts) when the whip is on and nearly +12 volts when the whip is off. Sync the scope on whip No. 1 and observe that No. 2, No. 3, and No. 4 follow in proper sequence.

calibration

The DSE manual suggests an obvious method of calibrating and checking a VHF Doppler: just walk around the vehicle with a transmitting handheld and adjust the calibration control on the front panel for correct bearings. But that method won't give optimum accuracy. It's adequate for only a very rough check. Nearby reflections and the near-field characteristics of the signal cause inconsistent and inaccurate indications.

Repeaters or strong base stations that are a mile or more away give better results. The signal should be strong and the path should be unobstructed. The antenna should be in a relatively clear area. For a mobile system, try a large, empty parking lot. Turn the antenna unit or drive the car around in a circle to verify that the bearing is reasonably consistent. Again, don't expect super accuracy on this check, particularly if the repeater is many miles away.

For mobile use, the best final calibration is done with the vehicle in motion. Drive slowly down a long stretch of straight, vacant road with a friend a quarter mile or so ahead, transmitting. With the other vehicle keeping pace ahead of you, adjust the calibration control until the top LED (zero degrees) is on. Now pass the signal source; after you pass, the bottom LED (180 degrees) should be on. Doing the calibration while in motion helps average out the local reflections which can throw off stationary bearings.

The calibration control on the front panel allows for correcting the display to match the orientation of the antenna unit. It also compensates for differing phase delays of the df tone through different receivers. Unfortunately, the control has less than ± 90 degrees of range. The display can be rotated in 90-degree steps for more calibration range by rotating the antenna connectors.

For example, let's say that with the signal straight ahead, the calibration control swings the indication from 190 to 330 degrees, but can't get it to zero degrees where we want it. The indication can be rotated 90 degrees clockwise by connecting antenna No. 4 to the D201 input, antenna No. 1 to the D202 input, and so forth. Now the calibration control covers the range 280 to 60 degrees for a straight-ahead signal, which includes the desired zero degree indication.

using a Doppler RDF in a vehicle

As with any RDF system, it's important to get to know the gear well before taking it out for an actual hunt. To become familiar with the unit, try to hunt local known signals for practice. The instantaneously updating display of a Doppler RDF unit is easy to read, but there are some subtleties in its interpretation. Remember that it can indicate only one bearing for each rotation of the antenna. When reflected signals approach the strength of the direct signal, the result in a Doppler RDF is a bearing indication that is incorrect for both the direct and reflected sources.

The best strategy is to keep moving and watch the general trend of the indications. By moving along, the effects of close-in reflections are averaged out. Take the time to learn to read the display and listen to the audio out of the speaker in different types of terrain and with different transmitting sites, power, and antennas.

As you drive around you'll note that the df tone in the receiver audio changes quality from smooth to "raspy." *Raspiness of the tone generally indicates that multipath is present.* Multiple Doppler signals are summing together in a random fashion, giving a high harmonic content to the resulting df tone. At worst the tone seems to jump in pitch by exactly one octave, and may stay high for a block or so. Put your greatest trust in the bearings indicated when the tone isn't raspy or an octave high.

limitations of Doppler RDF gear

Many newcomers to T-hunting have unreasonably high expectations of the many available Doppler RDFs. They think they'll be unbeatable in the local T-hunts. They also imagine that several Doppler RDFs linked for triangulation will locate jammers with pinpoint accuracy from dozens of miles away. Experienced hunters know that neither is true.

Tests by manufacturers of highly sophisticated commercial and military Doppler RDF systems such as Watkins Johnson, and by long-term users such as the U.S. Coast Guard Auxiliary, have shown that even the very best four-antenna designs have significant inherent inaccuracies when used for medium-distance bearings at fixed sites. Parasitic effects in the antenna system can cause an error of up to ± 5 degrees around the circle when the unused antennas are properly floated or terminated, and far more if they're not. The readout steps are 11.25 degrees, limiting resolution. On top of all this, atmospheric effects cause additional error. This error can be 15 degrees or more, varying with time of day. It is greatest if part of the path is over land and part over water.

Ten degrees of error at 10 miles causes the line of bearing to miss the source by 1-3/4 miles. Triangula-

tion from three high fixed sites 20 miles apart with a ± 10 degree error margin will produce an area of uncertainty 13.8 square miles in size. This is where the mobile hunters come in; when it comes to pinpointing the source of malicious QRM and gathering credible evidence, there's no substitute for a cadre of mobile hunters who've practiced their skills and become familiar with their gear.

Mobile hunting with any type of RDF setup can be a difficult task when the hunted operator uses sufficient cunning. Competitive hunters using Doppler RDF sets in southern California generally don't do better than teams using vehicle-mounted beams or quads. But the Doppler RDF's ease of use and rapid updating make it a good choice, particularly when you're hunting alone or hunting a mobile jammer. Having high accuracy is less important in a vehicle because the RDF is being used primarily as a "homing" device.

On the other hand, there are situations when a Doppler RDF isn't the best choice for the task. If the signal is very weak, the lack of gain and the residual switching noise in the Doppler antenna system will make it hard to get accurate indications. If the hunted signal is horizontally polarized, reflected signals (often vertical) will be emphasized with respect to the direct signal into the vertical whips. Again, it will be much more difficult to get an accurate bearing. In those situations, a high gain beam or quad, properly polarized, is a better choice for getting a high-accuracy bearing on the signal.

conclusion

A properly operating Doppler RDF really shines when used in a vehicle for closing in on a fixed or moving RF source. With the modifications suggested in this article, the Dick Smith K-6345 RDF does a respectable job without the need for major redesign. I'd like to hear from other users who discover further improvements.

acknowledgments

I want to thank fellow T-hunters J. Scott Bovitz, N6MI, and Jorge DiMartino, K16MD, for providing information and equipment that assisted in the evaluation and improvement of this unit. Also thanks to the dozens of transmitter hunters in my area who provide challenging hunts for testing of this and other RDF systems.

bibliography

Reprinted from *Transmitter Hunting — Radio Direction Finding Simplified*, (No. 2701), copyright 1987 by Tab Books, Blue Ridge Summit, Pennsylvania 17214. Available from Ham Radio's Bookstore, Greenville, NH 03048. \$17.95 plus \$3.50 shipping and handling.

ham radio

THE STANDARDS OF EXCELLENCE

SUPERIOR WEAK SIGNAL PERFORMANCE COMMERCIAL MODEM

COMPARE with ANY unit at ANY Price

Now Available With
PACKET RADIO

THE WORLD OF VHF/HF PACKET*,
CW, RTTY, ASCII AND NEW DUAL
AMTOR** IS AS CLOSE AS YOUR
FINGERTIPS WITH THE BRILLIANTLY
INNOVATIVE STATE-OF-THE-ART
MICRO-COMPUTER CONTROLLED
EXL-5000E.

SPECIAL SALE
\$795



SHOWN WITH OPTIONAL KANTRONICS KPC2400
AND MFJ-1270 TNC-2

Everything built in — nothing else to buy!

• AUTOMATIC SEND/RECEIVE—ANY SPEED ANY SHIFT • BUILT IN COMPUTER GRADE 5" MONITOR • EXTERNAL MONITOR JACK • TIME CLOCK ON SCREEN • TIMED TRANSMISSION AND RECEIVING • SELCAL • CRYSTAL CONTROLLED AFSK MODULATOR • PHOTOCOUPLER CW, FSK KEYS • ASCII KEY ARRANGEMENT • 15 CHANNEL BATTERY BACK-UP MEMORY • 1,280 CHARACTER DISPLAY MEMORY • SPLIT SCREEN TYPE-AHEAD BUFFER • FUNCTION SCREEN DISPLAY • PARALLEL PRINTER INTERFACE • SPEEDS: CW 5-100 WPM (AUTOTRACK), 12-300 BAUD (ASCII AND BAUDOT); 12-600 BAUD TTL; 100 BAUD ARQ/FEC AMTOR • ATC • RUB-OUT FUNCTION • AUTOMATIC CR/LF • WORD MODE • LINE MODE • WORD WRAP AROUND • ECHO • TEXT CURSOR CONTROL • USOS • DIDDLE • TEST MESSAGES (RY AND QBF) • MARK AND BREAK (SPACE AND BREAK) SYSTEM • VARIABLE CW WEIGHTS • AUDIO MONITOR CIRCUIT BUILT IN • CW PRACTICE FUNCTION • CW RANDOM GENERATOR • BARGRAPH LED METER FOR TUNING • OSCILLOSCOPE OUTPUTS • BUILT IN 100-120 / 220-240 VAC 50/60HZ AND 13.8VDC POWER SUPPLIES • AND MUCH, MUCH MORE • SIZE: 14W x 14D x 5H •

EXCLUSIVE DISTRIBUTOR: DEALER INQUIRIES INVITED FOR YOUR NEAREST DEALER OR TO ORDER:
AMATEUR-WHOLESALE ELECTRONICS TOLL FREE...800-327-3102
46 Greensboro Highway, Watkinsville, Georgia 30677 Telephone (404) 769-8706 Telex: 4930709 ITT



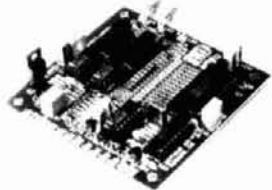
MANUFACTURER:
TONO CORPORATION
98 Motosoja Machi, Maebashi-Shi, 371, Japan

*PLEASE CALL FOR DETAILS

**Dual Amtor: Commercial quality, the EXL-5000E incorporates two completely separate modems to fully support the amateur Amtor codes and all of the CCIR recommendations 476-2 for commercial requirements.

Specifications Subject to Change.

THE ALL-IN-ONE DTMF DECODER



AUTO-KALL
AK-4
NEW!

194

- SELECTIVE CALLING MODE 2: 3 or 4 ring personal call group call call up all units and up to 15 groups each. AK-4 can respond to any or all group calls • 1 touch group call output • LED personal call group call and power indicators • variable timed output can be used with on-board relay to turn on a speaker
 - REMOTE CONTROL MODE: Locking/unlocking code can be programmed with different 4 digit 1-4
 - 121 to unlock #123 to lock #2 independently settable-removable locked outputs • 2 momentary outputs • On Board SPDT Relay can be used with any output • High Quality #14A, 3000000 decoder chip • Auto-fading warning number and courtesy • Low power CMOS chips
 - AK-4W: Wired/ Tested Boards: **\$89.95** (Plus \$2.00 Shipping/Handling)
 - AK-4K: PCB Kits: **69.95** (Plus \$2.00 Shipping/Handling)
 - AK-4H: Hardware Kit: **29.95** (Plus \$2.00 Shipping/Handling)
- (Hardware enclosure, speaker, spacers, switches, jacks, LED holders)

NET-KALL NK-1 THE ECONOMY DTMF DECODER

- Call all units and up to 15 individual groups. When triggered, outputs turn on for 5 to 2.5 seconds to drive buzzer from relay etc. or can stay on until manually reset
- NK-1W: Wired/ Tested Boards: **\$49.95** (Plus \$2.00 Shipping/Handling)
 - NK-1K: PCB Kits: **39.95** (Plus \$2.00 Shipping/Handling)

MoTRON ELECTRONICS

695 W. 21st Avenue • Eugene, Oregon 97405
TEL: (503) 687-2118 • TLX: 650-3157002 MCI
VISA • MasterCard • Check • COD

Save Time-Money with HAZER

- Never climb your tower again with this elevator system
- Antenna and rotator mount on HAZER, complete system trans tower in verticle upright position
- Safety lock system on HAZER operates while raising-lowering & normal position. Never can fall
- Weight transferred directly to tower. Winch cable used only for raising & lowering. Easy to install and use
- Will support most antenna arrays. ✓ 195
- High quality materials & workmanship
- Safety - speed - convenience - smooth travel - inexpensive
- Complete kit includes winch, 100 ft. of cable, hardware and instructions. For Rohn 25 G Tower

Hazer 2-Heavy duty alum. 12 sq ft. load **\$297.00 ppd.**
Hazer 3-Standard alum. 8 sq ft. load **213.00 ppd.**
Hazer 4-Heavy galv. steel. 16 sq ft. load **278.00 ppd.**
Ball thrust bearing TB-25 for any of above **42.50 ppd.**

Satisfaction guaranteed. Call today and charge to Visa or MasterCard.

As an alternative, purchase a Martin M-13 or M-18 aluminum tower engineered specifically for the HAZER system, or a truly self-supporting steel tower. Send for free details.



GLEN MARTIN ENGINEERING INC.
P.O. Box H 253 Boonville, Mo. 65233
816-882-2734

COMMODORE 64 LADDER NETWORK ANALYSIS PROGRAM "ALADYN-64" ✓ 196

This program is a menu-driven design tool with a built-in circuit file editor, fast calculations and graphic output to either the screen or printer. Useable for circuits which operate from VLF through Microwave. Circuit elements include R's, L's, C's, transmission lines, transistors and FET's. Output format rectangular or Smith chart.

\$59.95 PPD. Check or M.O.
INTERCEPTOR ELECTRONICS INC.
ROUTE 1, BOX 439, ROUND HILL, VA
22141-9307 PHONE (703) 338-4905

Subscribe Today To The World's Leading Magazine For Shortwave & Scanner Listeners!

- International Broadcasting
- Utility Monitoring
- Scanners
- Shortwave and Longwave
- Satellites
- Electronic Projects
- Listening Tips
- Frequency Lists
- Equipment Reviews
- News-breaking Articles
- Feature Articles
- Exclusive Interviews
- Insights by the Experts
- New Products



Each month **MONITORING TIMES**, the first wide-spectrum listener's publication and still the best, brings you 64 giant tabloid pages of late-breaking information on every aspect of monitoring the radio spectrum.

Fast-paced and information-packed, **MONITORING TIMES** consistently scoops the publishing industry.

ORDER YOUR SUBSCRIPTION TODAY before another issue goes by: only \$15 per year (U.S. and Canada), \$22 per year (foreign) or send \$1 for a sample issue (foreign send 2 IRCs).

MONITORING TIMES

P.O. Box 98

Brasstown, N.C. 28902

✓ 233

W6SAI BOOKS

published by Bill Orr, W6SAI and Stu Cowan, W2LX

BEAM ANTENNA HANDBOOK

Completely revised and updated with the latest computer generated information on BEAM Antenna design. Covers HF and VHF Yagis and 10, 18 and 24 MHz WARC bands. Everything you need to know. 204 illustrations. 268 pages. ©1985. Revised 1st edition.

RP-BA

Softbound \$9.95

SIMPLE LOW-COST WIRE ANTENNAS

Primer on how-to-build simple low cost wire antennas. Includes invisible designs for apartment dwellers. Full of diagrams and schematics. 192 pages. ©1972 2nd edition

RP-WA

Softbound \$9.95

ALL ABOUT CUBICAL QUAD ANTENNAS

Simple to build, lightweight, and high performance make the Quad at DX'er's delight. Everything from the single element to a multi-element monster. A wealth of information on construction, feeding, tuning and installing the quad antenna. 112 pages. ©1982. 3rd edition.

RP-CQ

Softbound \$7.95

THE RADIO AMATEUR ANTENNA HANDBOOK

A wealth of projects that covers verticals, long wires, beams as well as plenty of other interesting designs. It includes an honest judgement of gain figures, how to site your antenna for the best performance, a look at the Yagi-Quad controversy, baluns, slopers, and delta loops. Practical antenna projects that work! 190 pages. ©1978. 1st edition.

RP-AH

Softbound \$9.95

Please enclose \$3.50 for shipping and handling.



ham radio magazine **BOOKSTORE**
GREENVILLE, NH 03048 (603) 878-1441

locator field list

Compiled since 1982, this list uses the Maidenhead Locator system, adopted by IARU Region 2 and the ARRL in 1983. The largest unit in the system is a *field*. A field measures 20 degrees in longitude by 10 degrees in latitude, and is designated by two letters — for example, *RJ*. There are 324 fields on the earth's surface; the goal is to work all of them on the same band. This is a very difficult task — much more difficult than working all DXCC countries, partly because 54 of the fields are areas on the oceans and partly because very few stations know their own field designators. (Though it may be a long time before locator information becomes part of each QSO, we should all work towards this goal. By exchanging only six characters, such as JO99DK, we can identify the position of our stations within ± 10 km anywhere on earth.)

The middle unit of the locator is called a *square*. To help Amateurs identify their own and other squares, I've produced a 24-page atlas that shows all 32,400 squares worldwide. The atlas is available from Ham Radio's Bookstore (\$4.00 plus \$2.00 shipping and handling) or directly from me for six IRCs plus a large SASE (minimum size: 9 x 12 inches). The atlas also contains computer programs for determining both locator data (from longitude and latitude) and distance and direction between two locators.

All readers are invited to take part in this competition. The list covers all bands — from 1.8 MHz to 10 GHz — and includes the top 20 operators on each band. The rules are very simple and are presented at the bottom of each list, which is compiled four times per year.

If you'd like to participate, send your information to me as soon after the following dates as possible: March 31, June 30, September 30, and December 31.

By Folke Rosvall, SM5AGM, Vasterskarsringen
50, S-184 00 Akersberga, Sweden

AJ				BJ				CJ				DJ				EJ				FJ				GJ				HJ				IJ				JJ				KJ				LJ				MJ				NJ				OJ				PJ				QJ				RJ			
AI				BI				CI				DI				EI				FI				GI				HI				II				JI				KI				LI				MI				NI				OI				PI				QI				RI			
LOCATOR FIELD LIST 1987-03-31, COMPILED BY SM5AGM (JO99DK). WHO WILL BE THE FIRST RADIO AMATEUR TO WORK ALL 324 FIELDS ON THE SAME BAND?																																																																							
1.8 MHZ		1 W1JR FN 68 870330		2 SM3CWE JP 51 861231		3 SM6CTQ JO 33 850127		4 SM0LH JO 5 860322		5 SM4JXG JO 3 861231																																																													
3.5 MHZ		1 SM3CWE JP 129 861231		4 SM7WT JO 68 850129		7 SK6AW JO 44 870331		10 SM0LH JO 8 860322		11 SM4JXG JO 7 861231																																																													
7 MHZ		1 SM3CWE JP 141 861231		4 SM7WT JO 97 850129		7 SK6AW JO 50 870331		10 SM0LH JO 15 860209		13 9V1RH OJ 6 861211																																																													
10 MHZ		1 W1JR FN 43 870330		4 SM6INC JO 15 860331		7 SM6MSG JO 10 850930		10 SM0HTO JO 7 851230		13 SM5CAK JO 3 860921																																																													
14 MHZ		1 SM3CWE JP 221 861231		4 SM0CCE JO 186 850122		7 SK6AW JO 134 870331		10 SM5CAK JO 73 860921		13 SM4JXG JO 37 861231																																																													
18 MHZ		1 SM5ACO JO 12 870331		3 SM7BDB JO 8 850922		5 SM0LH JO 5 860322		SM0HTO JO 3 851230		2 SM6INC JO 9 860331		4 SM4JXG JO 7 861231		6 SM5PAX JO 3 850930		8 SM3CWE JO 2 861231																																																							
21 MHZ		1 SM3CWE JP 158 861231		4 SM6INC JO 109 860331		7 SM0HTO JO 52 851230		10 SM3CVM JP 24 861012		12 SM0CCE JO 153 850122		5 SM5ACO JO 95 850930		8 SM0LH JO 44 860209		11 SM5CAK JO 10 860921																																																							
24 MHZ		1 W1JR FN 25 870330		3 SM0HTO JO 5 851230		5 SM5ACO JO 4 861202		7 SM0LH JO 1 860209		2 SM6INC JO 9 860331		SM4JXG JO 5 861231		6 SM7BDB JO 2 850922		SM3CWE JO 1 861231																																																							
28 MHZ		1 DF2NJ JO 159 851111		5 SM0CCE JO 126 850122		9 SM0HJV JO 93 860917		13 SM0JXA JO 21 861101		2 SM6LIF JO 143 850909		6 SM3CWE JP 123 861231		10 SM5ACO JO 53 850930		14 SM4JXG JO 12 861231																																																							
50 MHZ		1 WA1OUB FN 46 860801		2 NOLL EM 41 861106		W1JR FN 41 870330		4 KA9MGR EN 16 860331		5 JO1GTC QM 5 861212																																																													
144 MHZ		1 SM7BAE JO 45 870214		SM2GGF KP 37 850622		9 YU3ZV JN 32 831231		OZ1EME JN 31 841224		17 OH7PI KP 28 831231																																																													
220 MHZ		1 W1JR FN 10 870330		2 KA9MGR EN 4 860331																																																																			
432 MHZ		1 K2UYH FN 33 850331		5 WB5LUA EM 28 840428		9 VE4MA EN 23 830331		13 K1FO FN 19 850318		17 DF9CY JO 10 830627																																																													
902 MHZ		1 W1JR FN 2 870330																																																																					
1.3 GHZ		1 K2UYH FN 20 850331		W7GBI DM 13 840505		OE9FKI JN 7 850331		SM0DJW JO 5 851231		W1JR FN 4 870330																																																													
2.3 GHZ		1 WAHKK EM 4 850304		3 SM6HYG JO 3 830331		5 OK1KIR JN 2 850221		7 PA0SSB JO 1 821231		WA4HGN EM 1 840505																																																													
3.4 GHZ		1 SM6HYG JO 1 850914																																																																					
5.7 GHZ		1 SM6HYG JO 1 850914		OZ1CFO JO 1 850930																																																																			
10 GHZ		1 SM0DJW JO 2 850630		YU1AW KN 2 860205		3 SM6HYG JO 1 850914		SM7ECM JO 1 860930		W1JR FN 1 870330																																																													

This list shows the number of fields worked according to the Maidenhead Locator system. A field is a block of 20° (longitude) x 10° (latitude). Rules: 1. All fields must have been worked via passive reflectors. 2. All stations involved must be on the earth's surface. 3. QSL cards are not required if you are sure that the other station considers the QSO complete. 4. All QSO's must have been worked from points within a circle of 1000 km radius. 5. There is no starting time for contacts to be eligible. A world map showing the 324 fields can be found in "The Radio Amateur's World (Locator) Atlas", that normally should be available at your national amateur radio society.
Compiled quarterly since 1982, the list shows the situation on March 31, June 30, September 30 and December 31 at 2400 UT. Please send your info as soon as possible after each date to SM5AGM, Folke Rosvall, Västernäringsgränd 50, S-184 00 Akersberga, Sweden. Tel. 0764-27638.

ham radio

We've Got Books Plenty of Books

Send SASE for free flyer

Ham Radio's Bookstore
Greenville, N. H. 03048

TELL YOUR FRIENDS
about
ham
radio

SCOPE BUY-OUT!!!

OS-106/USM-117 PORTABLE SCOPE, rugged military DC to 6 MHz unit with MX-2996 high-gain plug-in. Sweep 0.1 us to 0.1 sec in 19 steps. Sensitivity 0.01 to 20 V/div in 11 steps. 115 VAC 60 Hz; 8.5x9.8x15, 20 lbs sh. Used-reparable.....\$185 \$115 Checked...\$285 \$175



OS-106 with MX-2995 dual-trace plug-in (less MX-2996), repairable.....\$165 Checked.....\$225
MANUAL for USM-117, partial repro.....\$15
MANUAL for MX-2995, partial repro.....\$12

Prices F.O.B. Lima, O. • VISA, MASTERCARD Accepted.
Allow for Shipping • Write for latest Catalog Supplement
Address Dept. HR • Phone: 419/227-6573

FAIR RADIO SALES
1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

CADDELL COIL CORP.

35 Main Street
Poultney, VT 05764
802-287-4055

BALUNS

Get POWER to your antenna! Our Baluns are already wound and ready for installation in your transmatch or you may enclose them in a weatherproof box and connect them directly at the antenna. They are designed for 3-30 MHz operation. (See ARRL Handbook pages 19-9 or 6-20 for construction details.)

100 Watt (4:1, 6:1, 9:1, or 1:1 Impedance—select one)	\$10.50
Universal Transmatch 1 KW (4:1 Impedance)	14.50
Universal Transmatch 2 KW (4:1 Impedance)	17.00
Universal Transmatch 1 KW (6:1, 9:1, or 1:1—select one)	16.00
Universal Transmatch 2 KW (6:1, 9:1, or 1:1—select one)	18.50

Please send large SASE for info.

INTERFERENCE?

- ★ Interference Location
- ★ Stuck Microphones
- ★ Cable TV Leaks
- ★ Security Monitoring



- ★ VHF and UHF Coverage
- ★ Computer Interface
- ★ Speech Synthesizer
- ★ 12 VDC Operation

New Technology (patent pending) converts any VHF or UHF FM receiver into an advanced Doppler shift radio direction finder. Simply plug into receiver's antenna and external speaker jacks. Uses four omnidirectional antennas. Low noise, high sensitivity for weak signal detection. Call or write for full details and prices.

DOPPLER SYSTEMS, INC. P.O. Box 31819
Phoenix, AZ 85046 (602) 488-9755

ALL ABOUT VERTICAL ANTENNAS



by Bill Orr, W6SAI and
Stu Cowan, W2LX

Smart DX'ers know that the vertical antenna can be the secret to low band DX success. Theory, design, construction, operation—are fully covered by Ham Radio's well known columnist and book author Bill Orr in a clear concise easy-to-read text. Here's just a sample of what this exciting new book covers: Horizontal vrs vertical—which is best? Top loaded and helical antennas, 5 high efficiency Marconi antennas for 80 and 160, verticals and TVI—Is there a problem? The effects of ground on vertical antennas and a how to make an effective ground system, The Bobtail beam, construction data for 25 different antennas, matching circuits of all descriptions—which is best, plus P-L-E-N-T-Y more! 1st edition, 192 pages © 1986

RP-VA **Softbound \$10.95**

Please enclose \$3.50 shipping and handling

ham radio's bookstore
Greenville, NH 03048
603-878-1441



FALCON COMMUNICATIONS



Falcon Communications, Well Known for MOSFET Repeater Power Amplifiers, Also Makes A Hard Working Line Of Bipolar Power Amplifiers For Mobile Use.

For Information On Our Complete Line See Your Local Dealer Or Call Factory Direct

P.O. Box 8979 • Newport Beach, CA 92658 • (714) 760-3622

NUTS & VOLTS MAGAZINE

P.O. Box 1111-H
PLACENTIA, CA 92670
714-632-7721



- Ham Radio
- Computer Hardware
- Computer Software
- Plans-Kits
- Schematics
- Test Equipment
- CB Gear
- Satellite TV
- Video
- Components
- Antique Electronics
- Cable TV
- Publications
- Repairs-Services
- New Products
- Events Calendar

IF YOU ARE INTO ELECTRONICS AND SAVING MONEY IS IMPORTANT TO YOU, THEN YOU OWE IT TO YOURSELF TO TRY NUTS & VOLTS MAGAZINE. DISCOVER WHY THOUSANDS OF SMART PEOPLE NATIONWIDE TURN TO NUTS & VOLTS EACH MONTH TO MEET THEIR ELECTRONIC NEEDS. WHETHER YOU'RE BUYING, SELLING, OR JUST TRYING TO LOCATE THOSE UNIQUE OR HARD-TO-FIND ITEMS, FIND OUT HOW NUTS & VOLTS CAN HELP!

CHECK MONEY ORDER VISA MC

SUBSCRIBE TODAY!

Name _____

Address _____

City _____

State _____ Zip _____

Card No. _____ Exp. Date _____

CALL FOR ADVERTISING INFORMATION
DISTRIBUTOR INQUIRIES INVITED

Subscription Rates

U.S. FUNDS REQUIRED

3rd Class Mail - USA

One Year \$10.00
Two Years \$18.00
Lifetime \$50.00

1st Class Mail

One Year - USA . . \$18.00
Canada & Mexico . \$20.00

Air Mail

Foreign - 1 Year . . \$50.00

Includes one FREE 40-word
Classified Ad ✓ 204

A National Publication For The Buying And Selling Of Electronic Equipment

NEW PRICE!

ANTENNA POLARITY SWITCHER MODEL APS-1

The APS-1 is a self-contained control head designed to allow remote polarity switching of circular antennas such as the Mirage/KLM range of crossed yagis.

The APS-1 may be powered by the power adaptor (included) or may alternately be powered from a vehicle or other 13-17 VDC source.

In addition to switchable outputs for two antennas, the APS-1 also contains a 6-13 volt regulated DC power supply. This feature is designed for powering items such as preamplifiers, VHF/UHF converters, etc., but may also be used whenever a low-current stabilized variable voltage source is required.



SPECIFICATIONS:

Power Requirement (AC).....117V \pm 10% AC 50/60 Hz 15 Watt
 Power Requirement (DC).....11-16 VDC 500 mA

Outputs.....Two 12 VDC unregulated, switched (antenna relay supply).
 One 6-13 VDC variable regulated auxiliary supply.

Total output current 500 mA with AC transformer that is included, 1 amp with optional high current transformer or external DC supply. This unit has our popular five (5) year warranty.

P.O. BOX 1000 MORGAN HILL, CALIFORNIA 95037 (408) 779-7363
 OUTSIDE CALIF. (800) 538-2140 ✓ 199

**FACTORY
 DIRECT
 \$50.00**

✓ 200

SYNTHESIZED SIGNAL GENERATOR

MADE IN
 USA



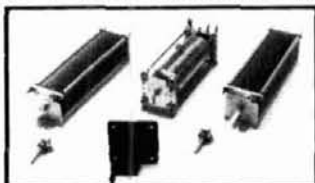
MODEL
 SG-100F
 \$429.95
 delivered

- Covers 100 MHz to 199.999 MHz in 1 kHz steps with thumbwheel dial
- Accuracy \pm 1 part per 10 million at all frequencies
- Internal FM adjustable from 0 to 100 kHz at a 1 kHz rate
- External FM input accepts tones or voice
- Spurs and noise at least 60 dB below carrier
- Output adjustable from 5-500 mV at 50 Ohms
- Operates on 12 Vdc @ 1/2 Amp
- Available for immediate delivery • \$429.95 delivered
- Add-on accessories available to extend freq range, add infinite resolution, AM, and a precision 120 dB attenuator
- Call or write for details • Phone in your order for fast COD shipment.

VANGUARD LABS

196-23 Jamaica Ave., Hollis, NY 11423
 Phone: (718) 468-2720 Mon. thru Thu.

1500 + WATT TRANSMATCH KIT \$154.95



BASIC KIT: INDIVIDUAL ITEMS

- 1 - rotary inductor 28 μ h.....\$53.60
- 2 - 6:1 ball drives.....\$6.00 ea.
- 1 - 0-100 turns counter.....\$59.50
- 2 - variable capacitors
 25-245 pf 4500 v.....\$28.00 ea.

OPTIONS—

- enclosure (pictured in Sept. 86 CQ).....\$60.00
- 4:1 balun kit.....\$22.50

dials, terminals, chassis, ceramic standoffs, hardware, toroids, amp components, B&W coil stock, etc.

OTHER KITS

- G3RUH, JAS1-1/FO-12 PSK Packet Modem...\$99.00
- PC Board for above only, delivered.....\$27.99
- Ten-Tec Designer Cabinet for above.....\$12.00
- K9CW Memory Contest Keyer.....\$109.00
- Oscar 10 Demodulator.....\$139.95
- 100 kHz to 60 MHz Converter for
 Yaesu FRG-9600.....\$94.95
- Light Pen for Tandy 1000, delivered.....\$32.95
- 50W 75M SSB XCVR.....\$199.95

Factory Wired

- Nel-Tech DVK-100.....\$229.00
- B&W PT-2500A Amp.....\$1,670.00
- B&W VS1500A Tuner.....\$384.00

Shipping Extra Unless Noted

1987 catalog \$1.00

RADIOKIT • P.O. Box 973-H
 Pelham, NH 03076 • (603) 635-2235



NEW

snap-on choke

**ELIMINATES
 RADIO FREQUENCY INTERFERENCE**

\$15 Pkg. of 4
 + \$2 for shipping

Order from your dealer or U.S. distributor:
computeradio
 Box 282, Pine Brook, NJ 07058-0282
 Tel. (201) 227-0712 Dealers welcomed

ELIMINATES RF INTERFERENCE IN: TV sets, Radios, Hi-Fi, PA systems, Telephones, VCRs, Test equipment, Burglar and Fire alarms, Modems, Monitors, Computers DUE TO: Domestic appliances, Radio Transmitters (CB, Ham Radio, Commercial), Industrial machinery, Cordless Telephones, Computers, Switching Systems.

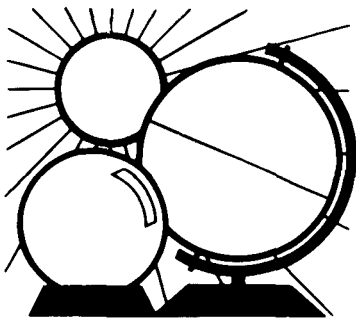
EASY TO USE: Fits onto small, large and ribbon cables. No need to rewire connectors. Unique, split ferrite core design fits up to RG8U coax cables.

WORKS IN "COMMON MODE", filters current induced in the braid of shielded cables and ground wires! Special ferrite material effective 0.5 - 200 MHz.

DOES NOT VOID EQUIPMENT WARRANTY

Manufactured and available in Canada from:
MANUFACTURING ✓ 201
 4087 HARVESTER RD. UNIT # 10 BURLINGTON, ONT. L7L 5M3

✓ 202



DX FORECASTER

Garth Stonehocker, KØRYW

summer thunderstorm noise

At any given moment an estimated 3600 thunderstorms are in progress around the world. They can be classified as air mass, frontal, or orographic, depending on how they are formed.

The main source of summertime QRN is the air mass thunderstorm, which builds up from the sun's heating the ground and the air above it. Most air mass storms form in afternoons when the humidity is above 50 percent, and last into the night before cooling off enough to dissipate. Air mass thunderstorms linger for several days until rain releases their moisture or they slowly move on. During the evening DXing hours, air mass thunderstorm QRN may limit the usefulness of low-band signals to local ragchewing and rule out, for the most part, weak-signal DX. This QRN, propagated from the equatorial land regions, or closer, increases the overall average noise level on the 80- and 160-meter bands which — except for a small peak at about 10 MHz — decreases as frequency is increased.

The noise can be minimized by careful operating practices. First, try to decrease the receiver bandwidth. You can go narrower until the signal you are demodulating becomes so distorted that readability is affected.

Then, by taking advantage of the directional properties of beam anten-

nas (either parasitic or driven), you can improve overall signal-to-noise ratios by literally steering clear of the major noise source locations. The tropical areas where the noise is mainly generated are concentrated over the land masses. Consulting a world map, look from your QTH toward land mass areas between the equator and the 23rd degree meridian. From the East Coast of the United States, this would be parts of Africa (longitude 10 degrees West); from the southern states, parts of Central America (longitude 75 degrees West); and from the western United States, Southeast Asia (longitude 120 degrees East). If you can avoid pointing your beam at these areas, you can help minimize noise pickup. In fact, if you can get the back of the antenna pointed in that direction, you can use the front-to-back ratio (typically 15 dB) to further decrease noise pickup. This may mean working a DX country over the long path or over the Pole. If the ionosphere will support propagation in that direction and no geomagnetic field disturbance is occurring, you may find that the solution to some of the summer noise problems.

last-minute forecast

The lower frequency bands are expected to be at their best the first two and a half weeks of the month. Solar flux should be low at this time, leading to better signals on east-west paths to Europe and Japan. Geomagnetic disturbances, possible from the 6th to 10th, may reduce MUFs on these paths so that only 80 and 160 meters are available, showing weak signals and QSB. The last two weeks of the month are the higher frequency bands' time to shine. Solar flux is expected to be highest then; MUFs should also be highest, making long-skip possible at this time. Of course, this is the month when numerous short-skip sporadic E openings are possible, with their subsequent positive effect on the higher bands. Check WWV at 18 minutes after the hour or the Space Environment Services Center (SESC) com-

puter bulletin board (303 497-5000) to verify the solar and geomagnetic data.*

A full moon will occur on the 11th; perigee (closest approach of the moon) is also on the 11th. The Aquarids meteor shower begins on July 18, peaks on the 28th, and lasts until August 7. (All dates are approximate, but close.) The radio-echo rate at maximum is about 34 per hour.

band-by-band summary

Six-meter paths will open for half an hour to a couple of hours on some days around local noon. Sporadic E propagation will make this short-skip path possible out to nearly 1200 miles per hop.

Ten, fifteen, twenty, and thirty meters will support DX propagation to most areas of the world during the daylight hours and into the evening with long-skip out to 2000 miles per hop. Sporadic E short-skip will also be available on many days for several hours around local noon. The direction of propagation will follow the sun across the sky: east in the morning, south at midday, and west in the evening. Long daylight provides many hours of good DXing. Solar flux is low this year, so daytime absorption allows higher signal strengths than usual on these bands during this month.

Thirty, forty, eighty, and one-sixty meters are the nighttime DXer's bands. On many nights, 30 and 40 meters will be the only usable bands because of thunderstorm QRN. Try the pre-dawn hours for best DX. The direction of propagation follows the darkness path across the sky: to the east in the evening, south around midnight, and toward the west in the pre-dawn hours. Skip distances will decrease to 1000 miles. Sporadic E openings will be observed most frequently around sunrise and sunset. These may be the only signals getting through the noise in the evening. Once again, because of the low solar flux, daytime DX — particularly in the mornings — may be good this month.

*See "DX Forecaster," May, 1987, page 105.

WESTERN USA

GMT	PDT	N	NE	E	SE	S	SW	W	NW
0000	5:00	20	30	20	12	20*	12*	12*	15
0100	6:00	20	30	20	12	20	10	10	15
0200	7:00	20*	30	20	15	20	10	10	15
0300	8:00	20*	30	30	20	20	10	10	15
0400	9:00	20	30	30	20	30	12*	12*	15
0500	10:00	20	20	20	20	30	12	12	15
0600	11:00	20	20	15	20	30	12	12	20
0700	12:00	20	20	15	20	30	12	15	20
0800	1:00	20	30	20	20	30	15	20	20
0900	2:00	30	30	20	20	40	15	20	20
1000	3:00	30	20	20	30	40	20	20	20
1100	4:00	30	20	20	30	40	20	20	30
1200	5:00	30	20	15	20	40	20	20	30
1300	6:00	20	20	12	20	40	20	30	30*
1400	7:00	20	20	12	15	40	20	30	30*
1500	8:00	20	20	12	15	40	20	30	30
1600	9:00	20	20	10	15	40	30	30	30
1700	10:00	20	20	10	12	30	20	30	30
1800	11:00	30	20	12	12	20	15	30	30
1900	12:00	30	20	12	12	20	15	20	20
2000	1:00	30	20	15	12	20	12	15	20
2100	2:00	30	20	20	10	20*	12	12	20
2200	3:00	20	20	20	10	15	12	12	20
2300	4:00	20	20	20	12	15	12	12	20

MID USA

MDT	N	NE	E	SE	S	SW	W	NW
6:00	20	20	20	12	20	10	10	15
7:00	20	30	20	12	20	10	10	15
8:00	20*	30	30	15	20	10	10	15
9:00	20	30	30	20	30	12	12	15
10:00	20	30	30	20	30	12	12	20
11:00	30	30	30	20	30	12	12	20
12:00	30	30	30	20	30	12	12	20
1:00	30	20	20	20	30	15	15	20
2:00	30	20	20	20	40	15	15	20
3:00	30	20	15	30	40	20*	20*	30
4:00	20	30	15	30	40	20	20	30
5:00	20	20	12	20	40	20	20	30
6:00	20	20	12	15	40	20	30	20
7:00	20	20	12	15	40	20	30	20
8:00	20	20	12	15	40	20	30	20
9:00	20	20	12	15	40	30	30	30
10:00	20	20	10	12	30	30	30	30
11:00	20	20	10	12	20	20	30	30
12:00	30	20	12	12	20	15	30	20
1:00	30	20	12	12	20	15	20	20
2:00	30	20	15	12	20	12	15	20
3:00	30	20	20	10	20	12	12	20
4:00	30	20	20	10	20	12	12	20
5:00	30	20	20	10	20	12	12	20
6:00	20	20	20	12	20	12	12	20

EASTERN USA

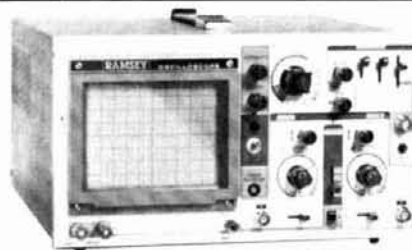
EDT	N	NE	E	SE	S	SW	W	NW
8:00	20	20	20	12	20	10	10	15
9:00	20	20	20	12	20	10	10	20
10:00	20	40	20	15	30	12*	10	20
11:00	20	30	30	20	30	12	12*	20
12:00	30	30	30	20	30	12	12	20
1:00	30	30	20	20	30	12	12	20
2:00	30	30	20	20	30	15	15	20
3:00	30	30	20	20	40	20*	15	30
4:00	20	30	20	20	40	20	20	30
5:00	20	20	20	30	40	20	20	30
6:00	20	20	15	20	40	20	30	20
7:00	20	20	15	20	40	20	30	20
8:00	20	20	12	20	40	20	30	20
9:00	20	20	12	15	40	20	30	20
10:00	20	20	12	15	40	20	30	20
11:00	20	20	10	12	40	30	30	30
12:00	20	20	10	12	30	30	30	30
1:00	20	20	10	12	20	20	30	30
2:00	20	20	12	12	20	15	30	20
3:00	30	20	12	12	20	15	20	20
4:00	30	20	15	10	20	12	12	20
5:00	30	20	20	10	20	12	12	20
6:00	30	20	20	10	20	12*	12	20
7:00	20	20	20	12	20	10	10	20

The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides MUF during "normal" hours.
*Look at next higher band for possible openings.

RAMSEY

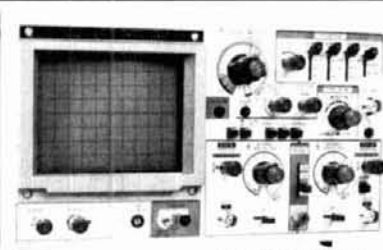
RAMSEY ELECTRONICS

QUALITY TEST GEAR YOU CAN COUNT ON



\$369.95*
20 MHz DUAL TRACE

Includes 2 hook-on probes
Features component testing circuit for resistors, capacitors, digital circuits and diodes—TV sync filter—high sensitivity—Z axis—XY mode—built-in calibrator—5X horizontal magnifier



\$499.95*
35 MHz DUAL TRACE

Includes 2 hook-on probes
wide frequency bandwidth—optimal sensitivity—delayed triggering sweep—hold off—ALT trigger—single sweep TV sync 5X magnification—XY or XYZ operation—HF/LF noise reduction



\$449.95*
15 MHz DUAL TRACE PORTABLE

Field/bench applications—built-in charger and battery pack—up to 2 hours operation per charge—5X horizontal magnification—high brightness CRT—front panel trace rotator

RAMSEY OSCILLOSCOPES

All Ramsey oscilloscopes feature unsurpassed quality at an unbeatable price. Of heavy duty construction, they are suitable for hobby, service and production applications.

*Add an additional \$10.00 for each unit for shipping.

MODEL	BAND WIDTH	# TRACES	CRT SIZE	VERTICAL SENSITIVITY	MAXIMUM TRIG FREQ	USEABLE MAXIMUM BANDWIDTH
2200	20 MHz	(2)	8x10CM	5 mV per div	35 MHz	30 MHz
2500	15 MHz	(2)	3.5 inch	2 mV per div	30 MHz	25 MHz
3500	35 MHz	(2)	8x10CM	1 mV per div	50 MHz	60 MHz

All include high quality 1:1, 10:1 hook on probes, instruction/service manual with schematic and component layout, 1 year warranty.

MINI-100 COUNTER



\$119.95 CHARGER, NICAD BATTERIES, AC ADAPTER INCLUDED

CT-70 7 DIGIT 525 MHz



\$139.95 WIRED, INCLUDES AC ADAPTER

CT-90 9 DIGIT 600 MHz



\$169.95 WIRED INCLUDES AC ADAPTER

CT-50 8 DIGIT 600 MHz



\$189.95 WIRED INCLUDES AC ADAPTER

CT-125 9 DIGIT 1.2 GHz



\$189.95 WIRED INCLUDES AC ADAPTER

MODEL	FREQ RANGE	SENSITIVITY	ACCURACY	DIGITS	RESOLUTION	PRICE
MINI-100	1-500 MHz	Less than 250mv	1 PPM	7	100 Hz, 1 KHz	119.95
CT-70	20 Hz-550 MHz	< 50mv to 150 MHz	1 PPM	7	1 Hz, 10 Hz, 100 Hz	139.95
CT-90	10 Hz-600 MHz	< 10mv to 150 MHz < 150mv to 600 MHz	1 PPM	9	0.1 Hz, 1 Hz, 10 Hz	169.95
CT-50	5 Hz-600 MHz	LESS THAN 25 mv	1 PPM	8	1 Hz, 10 Hz	189.95
CT-125	10 Hz-1.25 GHz	< 25mv @ 50 MHz < 15mv @ 500 MHz < 100 mv @ 800 MHz	1 PPM	9	0.1 Hz, 1 Hz, 10 Hz	189.95
CT-90 WITH DV-1 OPTION	10 Hz-600 MHz	< 10mv to 150 MHz < 150mv to 600 MHz	0.1 PPM	9	0.1 Hz, 1 Hz, 10 Hz	229.90

RAMSEY FREQUENCY COUNTERS

Ramsey Electronics has been manufacturing electronic test gear for over 10 years and is recognized for lab quality products at breakthrough prices. Our frequency counters have features and capabilities of counters costing twice as much. BP-4 Nicad battery pack for CT-70, CT-90 and CT-125 Frequency Counters. \$8.95.

205



RAMSEY D-4100
COMPACT DIGITAL MULTITESTER
\$249.95

test leads and battery included



Compact sized reliability and accuracy. This LCD digital multimeter easily fits in your pocket, you can take it anywhere. It features full overload protection • 3 1/2 digit LCD readout • recessed input jacks • safety probes • diode check function • 2000 hours battery life



RAMSEY D-5100
HAND HELD DIGITAL AUTORANGING METER
\$49.95

Includes Probes
1 Year Warranty

Has TOUCH-HOLD feature to allow readings to be logged or referred to before making the next reading. Up to 10 AMP current capability and a continuity function which beeps on zero Ohms.



\$449.95
wired includes AC adapter
PR-2 kit \$39.95

PR-2 COUNTER PREAMP

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for sniffing RF • ideal receiver/TV preamp



\$699.95
wired
PS-2 kit \$49.95

PS-2 AUDIO MULTIPLIER

The PS-2 is handy for high resolution audio resolution measurements, multiplies up in frequency • great for PL tone measurements • multiplies by 10 or 100 • 0.01 Hz resolution & built-in signal preamp/conditioner



\$899.95
wired includes AC adapter

PS-10B 1 GHz PRESCALER

Extends the range of your present counter to 1 GHz • 2 stage preamp • divide by 1000 circuitry • super sensitive (50 mV typical) • BNC connectors • 1 GHz in, 1 MHz out • drives any counter

MINI KITS—EASY TO ASSEMBLE—FUN TO USE—FOR BEGINNERS, STUDENTS AND PROS

TONE DECODER A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 50% K. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts. Complete kit: TD-1 \$5.95	COLOR ORGAN See music come alive! 3 different lights flash 3 different lights with music. One light each for high, mid-range and low. Each individually adjustable and drives up to 300 W runs on 110VAC. ML-1 Kit \$8.95	VIDEO MODULATOR Converts any TV to video monitor. Super-stable, tunable over ch 4-6. Runs on 5.15V accepts std. video signal. Best unit on the market! Complete kit: VD-1 \$7.95	FM WIRELESS MIKE Transmits up to 300' to any FM broadcast radio uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage. FM-1 Kit \$3.95 FM-2 Kit \$4.95	SUPER SLEUTH A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2W rms output runs on 6 to 15 volts. Uses B-45 9pin speaker. BN-9 Kit \$5.95	NEW TELEPHONE TRANSMITTER Low cost with professional performance. Features include: self phone line powered, tunable from 76 to 100 MHz polarity insensitive, compact size (1" x 1") easily installs anywhere on the phone line or inside the instrument itself. PB-1 Kit \$14.95	NEW FM RECEIVER For built-in applications or hobby experimentation. Full featured super-heterodyne receiver, microcell sensitivity, 10.7 MHz IF, integrated circuit detector, 50 mw audio amplifier, 9V external power source operation on standard FM broadcast band as well as large portions on each side, compact 16 square inch, for bug detection or reception. FR-1 Kit \$14.95	FM MINI MIKE A super high performance FM wireless mike kit. Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built-in electret mike. Kit includes case, mike, on/off switch, antenna, battery and super instructions. This is the finest unit available. FM-3 Kit \$14.95 FM-3 Wired and tested 19.95
40 WATT 2 mtr PWR AMP Simple Class C power amp features 6 times power gain 1 W in for 6 out, 2 W in for 15 out, 5 W in for 40 W out. Max output of 50 W incredible value, complete with all parts, less case and T-R relay. PA-1 40 W pwr amp kit \$22.95 TR-1 RF sensed T-R relay kit 6.95	VOICE ACTIVATED SWITCH Voice activated switch kit provides switched output with current capability up to 100 mA. Can drive relays, lights, LED or even a tape recorder motor. Runs on 9 VDC. VS-1 Kit \$6.95	LED BLINKY KIT Alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights. Runs on 3 to 15 volts. BL-1 Kit \$2.95	MAD BLASTER Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC. MB-1 Kit \$4.95	60 Hz TIME BASE Runs on 5-15 VDC. Low current (25ma) 1 min/month accuracy. TB-6 Kit \$5.50 TB-6 Assy \$9.95	UNIVERSAL TIMER Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Lives 500 tones, IC and includes a range of parts for most timing needs. UT-5 Kit \$5.95	WHISPER LIGHT An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W runs on 110 VAC. WL-1 Kit \$6.95	SIREN Produces upward and downward wail. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker. Complete kit: SM-3 \$2.95

ACCESSORIES FOR RAMSEY COUNTERS

Telescopic whip antenna—BNC plug	\$ 8.95
High impedance probe, light loading	16.95
Low pass probe, audio use	16.95
Direct probe, general purpose use	13.95
Tilt bail, for CT-70, 90, 125	3.95

PHONE ORDERS CALL
716-586-3950

TELEX 466735 RAMSEY CI
FAX 716-586-4754



TERMS: • satisfaction guaranteed • examine for 10 days; if not pleased, return in original form for refund • add 6% for shipping and insurance to a maximum of \$10.00 • foreign add 15% for surface mail • CDD add \$2.50 (CDD in USA only) • orders under \$15.00 add \$1.50 • NY residents add 7% sales tax • 90 day parts warranty on all kits • 1 year parts & labor warranty on all wired units.

RAMSEY ELECTRONICS, INC.
2575 Baird Ave.—Dept. HR
Penfield, N.Y. 14526



product

REVIEWS

the versatile PAKRATT

Amateur Radio is really dozens of hobbies in one, with communication by radio the common thread. Some of us are dedicated to only one aspect — DXing, for example. Others want to sample many areas. If you're one of the latter, and have an interest in digital communications, the AEA PK-232 may be for you, particularly if you already have a computer with an RS-232 serial port.



The PK-232 works on Packet, AMTOR, RTTY, and CW on both hf and VHF. By the time you read this, AEA will be shipping an upgrade kit that will let you add software for decoding weather facsimile signals, too.

When RTTY was young, I had a teleprinter that weighed more than I did. With the advent of the microcomputer revolution, RTTY has become much simpler — nowadays it doesn't take much more than a computer and an appropriate interface. One of the more versatile interface designs is the AEA PK-232 Controller. Weighing in at about 3 pounds, it decodes Packet, CW, RTTY, and AMTOR signals. Connect it to any computer with an RS-232 serial port, and you're in the digital end of ham radio.

The PK-232's operating manual covers just about anything you need to know, including the standard advice to "Read the entire manual before you begin" What ham is ever going to do that? Fortunately, there's a section titled "Quick Start Installation," and that's where I began. The instructions on how to connect the PK-232 to my pc clone and to my radio are clear and easily followed.

The manual also includes a helpful appendix of instructions for connecting the PK 232 to several of the most popular radios. Though this appendix wasn't referenced in the Quick Start chapter, I found it on my own after I'd hooked up my handheld.

For a computer to act as a terminal, a terminal emulation program is required. I began with a 300-baud Dumb Terminal program. The

PK-232 defaults to 1200, but I sent a couple of asterisks and the PK-232 adjusted to 300 baud automatically. (It handles 110 to 9600 baud, with the rate set by command.)

Using the cables supplied, I hooked the Pakratt to my VHF handheld. With just a Rubber Duck for an antenna, I was able to copy one side of a QSO. (I'll use the call "W4AAA" as an example.) When the QSO ended, I typed "C W4AAA" and a couple of seconds later my screen showed "**** CONNECTED W4AAA"! That was almost as good as my very first QSO, (a l-o-n-g time ago.) It was brief. I "DISCONNECT-ed" and read more of the manual, discovering that I needed three small flashlight batteries in the unit to make sure it remembered my call and my choice of baud settings as well as other parameters.

Hooked up to an outside whip, I could hear several stations on the handheld, so I tried connecting to myself through a digipeater. Any Packet station, of course, can act as a digipeater (unless it's told not to), so I typed in "C VE3ZL VIA W4AAA" and got "**** CONNECTED." I checked six or seven more stations and found that two or three of them were accessible as digipeaters.

In my ordinary Amateur operating, I do a lot of listening. The same was true when I started using the PK-232. A front panel switch lets you switch between two radios at will (in my case the VHF handheld and my SSB hf rig), so after listening to Packet for awhile on 145.01 MHz, I switched to the hf rig and copied some hf Packet on 20 meters. I was pleasantly surprised to find how easy it was to tune hf signals using the front panel bargraph LED indicator. And the PK-232's ability to copy weak-signal CW was better than I expected it would be.

Operating the PK-232 is fun, and although it's easy to go from any one mode to another, I find that most of my operating is on RTTY on 20 or Packet on 2 meters.

If you're already active on Packet, you may have noticed a message about the PK-232 on some bulletin boards indicating that the wide shift (1000 Hz) used by the PK-232 in RTTY mode isn't authorized by the FCC. *This is not so.* Part 97.69 (a)(2) of the latest FCC rules permits 1000 Hz shift — so not to worry!

The PK-232 uses a Z-80 microprocessor, with software in PROM's. Twenty indicator LED's on the front panel let you keep tabs on what's going on.

The PK-232 is priced at \$319.95 (Amateur Net). It takes 12 VDC at about 0.7 amp. A power adapter is available for \$25.00.

For more details, contact Advanced Electronic Applications, Inc., P.O. Box C-2160, Lynnwood, Washington 98036.

— VE3ZL

Circle #301 on Reader Service Card.

shirt pocket multimeter

Like most Hams, I'm a sucker for neat little gadgets. So when Eaglestone, a division of Siber

Hegner of North America, sent me one of their new Ishii Checkman DM-1000 multimeters for review, I jumped at the opportunity.



Over the years I've used plenty of different multimeters — from the heaviest analog, drop-in-from-the-Empire State-Building-and-they'll-still-work-units to handheld models with digital LCD readouts. What makes the Ishii Checkman unique is that it's the first one that I've seen that will actually fit in *my* shirt pocket, yet can still be regarded as a commercially reliable instrument.

Weighing in at just 100 grams and measuring only 4 1/2 x 3 x 1/2 inches in size, the Checkman is a three-function tester; you can measure dc volts, ac volts, and resistance. The dc volt range is from 200 mV to 500 volts, with an accuracy of ± 2 percent at 200 mV and 1.3 percent at 500 volts. Its ac volt range is 2 to 500 volts at 2.3 percent accuracy, from 40 to 500 Hz. Resistance can be measured from 200 ohms to 20 megohms, with an accuracy of 2 percent at 200 ohms and 10 percent at 20 megohms.

All ranges are automatically set by the meter. Input impedance is 12 megohms at 2 volts and 11 megohms for other ranges. Operating on the principle of dual slope integration, the meter samples the circuit under test twice per second, indicating its readings on a 3.5-digit LCD readout measuring 10 m high.

In tests run using an analog VTVM and another digital multimeter as a control, the Checkman compared favorably. The margin of difference between the three units was insignificant in each test.

This is a neat little meter. It weighs practically nothing and really *will* fit in your shirt pocket. Technicians will find it easy to carry all day on the job; you'll no doubt appreciate its small size and portability, too.

Covered by a 30-day, money-back guarantee and a full one-year warranty, the Checkman is available from Eaglestone, 84 Research Drive, Milford, CT 06460.

— N1ACH

**SAY YOU SAW IT
IN
HAM RADIO**

800-882-1343



IC-735 List Jun's

IC-735 Gen. Cvg. Xcvr	\$999.00	Call \$
IC-751A Gen. Cvg. Xcvr	1649.00	Call \$
R7000 Gen. Cvg. Rcvr.	1099.00	Call \$
R71A Gen. Cvg. Rcvr.	949.00	Call \$
IC-27A/H FM Mobile 25w/45w	429/459	Call \$
IC-28A/H FM Mobile 25w/45w	429/459	Call \$
IC-37A FM Mobile 25w	499.00	Call \$
IC-47A 440 Mobile 25w	549.00	Call \$
IC-04AT UHF HT	449.00	Call \$
IC-48A UHF 45w	459.00	Call \$
IC-38A FM Mobile 25w	459.00	Call \$
IC-02AT FM HT	399.00	Call \$
IC-12AT Micro HT	329.00	Call \$



TS-440S/AT

TS-940SAT Gen. Cvg. Xcvr	\$2249.95	Call \$
TS-430S Gen. Cvg. Xcvr	819.95	Call \$
TS-711A All Mode Base 25w	899.95	Call \$
TR-751A All Mode Mobile 25w	599.95	Call \$
TM-201B FM Mobile 45w	369.95	Call \$
TM-2530A FM Mobile 25w	429.95	Call \$
TM-2550A FM Mobile 45w	469.95	Call \$
TM-2570A FM Mobile 70w	559.95	Call \$
TH-205 AT, NEW 2m HT	259.95	Call \$
TH-215A, 2m HT Has It All	349.95	Call \$
TH21BT 2M HT	259.95	Call \$
TH31BT 220 HT	269.95	Call \$
TH41BT 440 HT	269.95	Call \$



FT 757GX

FT-757 GX Gen. Cvg. Xcvr	995.00	Call \$
FT-767 4 Band New	1895.00	Call \$
FT-270RH FM Mobile 45w	439.95	Call \$
FT-290R All Mode Portable	579.95	Call \$
FT-23 R/TT Mini HT	299.95	Call \$
FT-209RH RM Handheld 5w	359.95	Call \$
FT-726R All Mode Xcvr	1095.95	Call \$
FT-727R 2M/70CM HT	479.95	Call \$
FT2700RH 2M/70CM 25w	599.95	Call \$



3919 Sepulveda Blvd.
Culver City, CA 90230
213-390-8003

TOWERS

by ALUMA

HIGHEST QUALITY ALUMINUM

- TELESCOPING (CRANK-UP)
- GUYED (STACK-UP)
- TILT-OVER MODELS

Easy to install. Low Prices.
Crank-ups to 100 ft.

EXCELLENT FOR AMATEUR COMMUNICATIONS

Over 36 types aluminum and steel towers made—specials designed and made—write for details

SPECIAL Four Section 50 Ft. Van Mounted Crank-Up Aluma Tower

ALUMA TOWER CO.
BOX 2806HR
VERO BEACH, FLA. 32960-2806
(305) 567-3423 TELEX 80-3405



220-MHz HT

Yaesu U.S.A. has introduced the FT-109RH, a 5-watt, 220-MHz handheld transceiver. The FT-109RH joins the popular 2-meter FT-209RH 2 and the 440-MHz FT-709R handhelds.

The FT109RH covers the frequency range of 220 to 224.995 MHz in 5- or 10-kHz steps. All features of previous models are incorporated, including the exclusive Yaesu battery saver, ten memories, standard or non-standard offset, as well as memory and priority scanning. The unit comes equipped with a DTMF tone generator; a front panel multimeter indicating battery condition, transmitter power output, or received signal strength; and a VOX system for hands-free operation. All optional accessories are interchangeable with other units in the FT-109, 209, 709 series, including a VOX headset, speaker/mic, programmable tone squelch, dc car adapter, quick/trickle desk charger, and a durable leather case.

For details, contact Yaesu U.S.A. Amateur Products Division, 17210 Edwards Road, Carri-
tos, California 90701

Circle #303 on Reader Service Card.

SPECIALIZED COMMUNICATIONS FOR TODAY'S RADIO AMATEUR!



48 pages per issue!

Since 1967, covering all modes of Amateur Radio "specialty" communications; Fast Scan TV, SSTV, FAX, Packet Radio, Computers, RTTY, AMTOR, Satellites, TVRO, Microwave, Lasers and more! 10 issues per year. Back issues available, SASE brings TRS80C, C64, IBM software catalog. U.S. subscribers \$20/year. Foreign slightly higher. Add \$2.00 for Index Issue.

SPEC-COM Communications & Publishing Group
P.O. Box H,
Lowden, Iowa
52255



5% Added

new compact speaker

MFJ Enterprises, Inc. has announced the release of its MFJ-280, a high quality compact speaker for only \$18.95.

This unit is a rugged, compact mobile speaker with a tilt bracket on a magnetic base. It comes with a 3-1/2-mm phone plug on the end of a long cord and works well with all 8- and 4-ohm impedances and can handle up to 3 watts of audio. Its dark gray color harmonizes with nearly all rigs.

This MFJ product comes with MFJ's double guarantee. If ordered from MFJ, it may be returned within 30 days for a full refund, less shipping. MFJ also backs this product with its one-year unconditional warranty.

For more information, contact MFJ Enterprises, Inc. P.O. Box 494, Mississippi State, MS 39762.

Circle #302 on Reader Service Card.

PCPLOT version 3

BV Engineering has just released version 3 of its PCPLOT high-resolution graphics program. Now PCPLOT not only makes linear and logarithmic plots, but will also plot line graphs with error bars, stock market charts, bar charts, and stacked bar charts. PCPLOT supports two in-

dependent Y-axes which can be scaled to different data sets. Data points can be connected with dotted, dashed, or solid lines. Open plots, grid lines, or tick marks may be specified. You can mix line graphs, bar charts, stacked bar charts, stock market charts, and error bars on a single graph. X and Y data may be separately scaled. Legends can be specified on an individual data file basis. Alphanumeric labels can be placed anywhere on the plotting surface. AUTO features enable PCPLOT to take instructions from a file instead of the keyboard.

PCPLOT is compiled in machine code to run quickly. A complete semi-log graph of two data files, each containing 200 data points, takes only 1 minute on a stock IBM PC.

PCPLOT Version 3 sells for \$95.00 and runs on the PC DOS and MSDOS operating systems.

For information, contact BV Engineering, 2200 Business Way, Suite 207, Riverside, California 92501.

Circle #306 on Reader Service Card.

new QTH for Kenwood

Because of Kenwood's growth over the last several years, it has become necessary to move into a new, larger facility. The building spans over ten acres in Carson, California and employs 200 in the warehouse and offices.

This move represents the final phase of Kenwood's consolidation process, in which Kenwood Electronics and Trio-Kenwood Communications will be joined by a new division, the Test Equipment Group. Collectively, the communications and test instruments sections will create a new group within the Kenwood Corporation, called the Communications and Test Equipment Group.

The new office is located at 2201 East Dominquez Street, Carson, California 90810.

ultralinear amplifier

WI-COMM Electronics' "Superlam" series now includes the WLA06M Wideband Ultralinear Amplifier, a broadband, feed-forward amplifier covering the frequency range from 0.4 to 80 MHz. This unit employs a field-proven, feed-forward linearization technique to achieve distortion performance equivalent to a 100-watt linear power amplifier. The 3rd order and 2nd order intercept points are typically 62 dBm and 95 dBm, respectively. A linear output power of 1 watt can be delivered into a 50-ohm load with 20 dB of gain. Noise figure is 6 dB and VSWR is better than 1.5:1. Standard powering is 25 ± 1 VDC, 600 MA.

The amplifiers are housed in a die-cast blue aluminum case with BNC female connectors. The unit is particularly suitable for signal distribution networks, receiver multicouplers and intermodulation testing.

For more information, contact WI-COMM Electronics Inc., P.O. Box 5174, Massena, New York 13662.

Circle #304 on Reader Service Card.

cable and connector guide

Nemal Electronics International has released its new 1987 Cable and Connector Selection Guide. The 36-page guide includes more than 100 new cable and connector products covering a wide array of rf coaxial, microwave, broadcast, communications, and data applications. Extensive cross-references and illustrations simplify selection of the appropriate cable, connector and tooling for any application. The guide also includes information on the design and production of Nemal's line of Cable Assemblies.

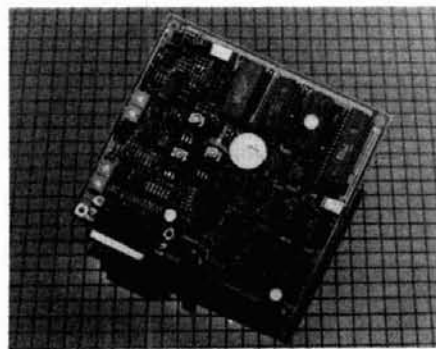
For a copy of the guide, contact Nemal Electronics, Inc., 12240 N.E. 14th Avenue, North Miami, Florida 33161.

Circle #307 on Reader Service Card.

repeater controller

The new S-COM "5K" repeater controller is a low-cost, compact addition to S-COM's line of repeater controllers. The state-of-the-art CMOS microprocessor design supports both a repeater and a control receiver, and requires only 60 mA at 12 Vdc. Applications include control of main site repeaters, remote receiver links, portable repeaters, and emergency repeaters.

Operating parameters such as ID call signs, courtesy message, timeout timer, pre- and post-timeout messages, CW pitch, and CW speed, are remotely programmable via DTMF commands, eliminating trips to the repeater site for programming changes. Data is retained in non-volatile memory. Three logic inputs and three logic outputs are provided for site control and monitoring purposes.



Among other features are CW shaping, a watchdog monitor, flexible repeater interfacing, a CW clock and calendar, DTMF muting, security passwords, a "polite" identifier, transient protection, power MOSFET outputs, and high-quality G10FR glass epoxy PC board. The board measures 5 1/2 by 6 inches, with the tallest component only 1/2 inch above the board.

Options include full IC socketing, a 1 3/4 x 19-inch rack mount cabinet, a wall-mount power supply, and an audio delay module. The assembled and tested board, with all connectors and manual, is priced at \$179.

For information, contact S-COM Industries, P.O. Box 8921, Fort Collins, Colorado 80525.

Circle #308 on Reader Service Card.

YOU NAME IT. WE'VE GOT IT!

At Consolidated Electronics Inc. we carry over 10,000 parts and products such as: fuses, semiconductors, batteries, capacitors, resistors, wire, cables, connectors, antennas, chemicals, speakers, test equipment, soldering equipment, styli and cartridges, video heads, telephone accessories, and more. Consolidated Electronics is an authorized distributor for:

- | | | |
|---|--------------------------------------|--|
| <input type="checkbox"/> Action* | <input type="checkbox"/> GE* | <input type="checkbox"/> Plumb* |
| <input type="checkbox"/> Amperex* | <input type="checkbox"/> LPS* | <input type="checkbox"/> SAMS TM |
| <input type="checkbox"/> Amphenol* | <input type="checkbox"/> Loctite* | <input type="checkbox"/> Simpson* |
| <input type="checkbox"/> Argos* | <input type="checkbox"/> Kester* | <input type="checkbox"/> Tech Spray TM |
| <input type="checkbox"/> Beckman TM | <input type="checkbox"/> Mercer TM | <input type="checkbox"/> Thordarson* |
| <input type="checkbox"/> B&K Precision TM | <input type="checkbox"/> Nicholson* | <input type="checkbox"/> Ungar* |
| <input type="checkbox"/> Bogan* | <input type="checkbox"/> O.C. White* | <input type="checkbox"/> VIZ TM |
| <input type="checkbox"/> Burgess* | <input type="checkbox"/> O.K. Tools* | <input type="checkbox"/> Waber* |
| <input type="checkbox"/> CTS* | <input type="checkbox"/> Panavise* | <input type="checkbox"/> Wahl* |
| <input type="checkbox"/> Electro Voice* | <input type="checkbox"/> Pedro* | <input type="checkbox"/> Weller* |
| <input type="checkbox"/> Fluke* | <input type="checkbox"/> Philips* | <input type="checkbox"/> Xcelite* |

All part orders shipped in 24 hours.
2 Year warranty on all parts.
Call toll free today.

1-800-543-3568

CONSOLIDATED

ELECTRONICS

705 Watervliet Ave. Dayton, Ohio 45420-2599
Tel. (513)252-5662 Telex 288-229 FAX 513 252-4066

✓ 208

ANTENNA And TOWER ACCESSORIES

MAST ADAPTERS
MA-2 \$22.50 NEW MA-3 \$29.50

BEAM MOUNT
BM-1 \$34.50

STANDOFFS
SO-1 \$34.50
SO-2 \$64.50
SO-3 Commercial Antenna Standoff \$99.50

GP-81 \$129.50
GP-51S \$139.50
BG-18 Ladder Mast \$249.50

Pully Kit \$8.50

FOB Oaklawn

NEW FREE CATALOG NOW AVAILABLE
IIX EQUIPMENT LTD.
P.O. Box 9 Oaklawn, IL 60454
(312) 423-0605

✓ 209

1986-87 CALL DIRECTORY

Call Directory \$8
Name Index \$8
Geographic Index \$8

All three — \$20
Shipping per order \$3

BUCKMASTER PUBLISHING
Mineral, Virginia 23117
703-894-5777

✓ 210

MULTI-BAND SLOPERS

ALSO DIPOLES & LIMITED-SPACE ANTENNAS

Outstanding performance of WINN antennas is well known. Now enjoy multi-band BIG-SIGNAL reports! Automatic bandswitching - Very low SWR - Coax feed - 3kw power - Compact - FULLY ASSEMBLED to your specified center frequency each band - EASY TO INSTALL - VERY low profile - Complete instructions - Your personal check accepted

4 BAND SLOPER - 160, 80, 40, 30, or 20M	60 ft. long	\$ 48 ppd
3 " " " " " " " " " " " " " " " "	60 ft. "	\$ 43 "
2 " " " " " " " " " " " " " " " "	40 ft. "	\$ 35 "
3 " " " " " " " " " " " " " " " "	113 ft. long	\$ 71 "
2 " " " " " " " " " " " " " " " "	85 ft. "	\$ 55 "

9 BAND SPACE-SAVING DIPOLE - 160 thru 10M* \$61.00 ppd \$ 85 ppd
* Requires wide-range tuner (80, 40, 20, 15M without tuner)

SEND SASE for complete details of these and other unique antennas

WINN ANTENNAS
BOX 393-M MI. PROSPECT, IL 60056

✓ 211

RUTLAND ARRAYS

PRESENTING

THE FINEST 432 MHZ ANTENNAS AVAILABLE

NOW AVAILABLE: FO-33 17.9 DBD GAIN 33EL 24FT **\$159.95**

THE FO-22 15.8 DBD MEASURED GAIN 22EL 14FT \$76.64

AN OUTSTANDING ANTENNA FOR EME—WEAK SIGNAL—TROPO

THE RIW-19 14.9 DBD MEASURED GAIN 19EL 13FT \$69.95 FOR EME—TROPO—ATV

Assembly time 1 hr. per antenna.

Add \$6 UPS, S/H for single or pair of antennas, \$8 west of the Mississippi. PA residents add 6% state tax.

ALSO AVAILABLE: Power Dividers—Stacking frames
Write for details and Price Sheet

RUTLAND ARRAYS

1703 WARREN STREET
NEW CUMBERLAND, PA 17070

✓ 213



SSB ELECTRONIC TRANSVERTERS & PREAMPLIFIERS

LT 2S	144/28 XVRTR 20W GaAsfet DBM	\$549
LT33S	902/144 Xvrtr 20W GaAsfet	\$599
LT23S	1296/144 Xvrtr 10W GaAsfet	\$549
MICRO-13	2304/144 XVRTR 0.5W GaAsfet	\$429
MICRO-X	10368/144 Xvrtr 0.1W GaAsfet	\$599
DX	series low noise GaAsfet preamps	from \$129
MV	series mast mounted GaAsfet preamps	\$199
K	series rx cnvtrs GaAsfet DBM from	\$129

TRANSVERTERS UNLIMITED

T220/28	220 MHz Xvrtr 28 or 50 IF, 20 W	\$220
T144/28	144 Hz Xvrtr 28 or 50 IF, 25 W	\$199
PA33200	902 MHz 2 tube PA, 200W +	\$499
PA23150	1296 2tube PA, 150 + W	\$449
PA1325	2304 1tube PA, 25 + W	\$429
HF400	High power relay 2Kw at 144 MHz	\$129
RK500	Medium power relay 1KW at 144 MHz	\$ 69

Call or write for catalogue.

TRANSVERTERS UNLIMITED

BOX 6286 STATION A
TORONTO, ONTARIO
CANADA M5W 1P3
(416) 759-5562

TRANSVERTERS UNLIMITED

(US)
P. O. BOX 178
NEW BOSTON, NH 03070

✓ 214

IF YOU BUY, SELL OR COLLECT OLD RADIOS, YOU NEED...

Antique Radio's Largest-Circulation Monthly Magazine

ANTIQUE RADIO CLASSIFIED

Articles - Classifieds - Ads for Parts & Services.

Also: Early TV, Ham Equip., Books, Telegraph, 40's & 50's Radios & more...

Free 20-word ad each month. Don't miss out! Sample - Free. 6-Month Trial - \$10.

1-Year: \$18 (\$24 by 1st Class). Foreign - Write.

A.R.C., P.O. Box 2-A2, Carlisle, MA 01741

✓ 215

MADISON

Electronics Supply, Inc.
3621 Fannin St. • Houston, Texas 77004



BELDEN

BELDEN

9913 low loss, solid center conductor, foil & braid shield - excellent product	45c/ft
8214 RG8 foam	43c/ft
8237 RG8	40c/ft
8267 RG213	52c/ft
8262 RG-58 cu milspec	16c/ft
8000 14ga stranded copper ant. wire	13c/ft
8448 8 conductor rotor cable	31c/ft
9405 as above but HD-2-16ga, 6-18ga	52c/ft
8403 Mic cable 3 condctr & shield	80c/ft
100 feet 8214 wends installed	45.00
9258 RG 8X	19c/ft

POLICIES—MASTERCARDS, VISA or C.O.D.

All prices FOB Houston, Texas, except as noted. Prices subject to change without notice, subject to prior sale. Used gear sale price refunded if not satisfied. Call anytime to check status of your order. Texas residents add sales tax.

✓ 212

FOR MORE INFORMATION CALL

outside Texas

1-800-231-3057

Texas and outside U.S.

1-713-520-7300

This publication is available in microform from University Microfilms International.



Please send information about these titles:

Name _____

Company/Institution _____

Address _____

City _____

State _____ Zip _____

Phone () _____

Call toll-free 800-521-3044. In Michigan, Alaska and Hawaii call collect 313-761-4700. Or mail inquiry to: University Microfilms International, 300 North Zeeb Road, Ann Arbor, MI 48106.



spring catalog

Heath's colorful new catalog features more than 400 electronic kit products, including a 9-inch diagonal color television, a new security light control, special savings and a Partnership Pack gift offer that's free with every computer purchase.

For a free copy, contact Heath Company, Dept. 150-925, Benton Harbor, Michigan 49022. (In Canada, contact Heath Company, 1020 Islington Avenue, Toronto, Ontario M8Z 5Z3.

Circle #309 on Reader Service Card.

tone output switch module

Communications Specialists, Inc. is now offering a Tone Output Switch Module as an add-on accessory for their TP-38 Shared Repeater Tone Panel. Dubbed the TP-TOS, this new accessory provides individual discrete switch outputs for the standard 32 tone frequencies from 67.0 to 203.5 Hz. The 32 outputs can be configured to provide either a pull to logic ground, a pull to logic high, or to route an audio signal to another transmitter, receiver, tape recorder, etc. The TP-TOS is available on new TP-38's or may be factory-retrofitted into existing units. Priced at \$99.95, the TP-TOS is in stock and is covered by a one-year factory warranty. A catalog is available on request.

For details, contact Communications Specialists, Inc., 426 West Taft Avenue, Orange, California 92665.

Circle #310 on Reader Service Card.

six-digit jumbo LED clock

Model 1036 has 12- or 24-hour display capability with six 2.25-inch red LED digits. The battery-backed up quartz crystal time base automatically



takes over during power failures. (The clock will also operate from 12 volts dc.) The dimensions are 15.25 x 4.75 x 1.5 inches, providing a viewing distance of over 100 feet.

The model 1036 is available in kit form with step-by-step instructions for \$69.95 or assembled and tested for \$99.95. (For green LEDs, specify Model 1036G and add \$10.00.) For more information, contact NRG Electronics, P.O. Box 24138, Fort Lauderdale, Florida 33307.

Circle #311 on Reader Service Card.

New

New

THE STANDARD OF EXCELLENCE

Definitely Superior!

AZDEN PCS-5000

COMMERCIAL — GRADE

**NOW AVAILABLE
PCS-5800 H
45 Watts
10 Meter FM**



UNPRECEDENTED WIDE FREQUENCY RANGE: Covers 140,000-153,000 MHz in steps that can be set to *any* multiple of 5 kHz up to 50 kHz.

CAP/MARS/NAVY MARS, BUILT IN: The wide frequency range facilitates use of CAP and ALL MARS FREQUENCIES including NAVY MARS. **COMPARE!**

TINY SIZE: Only 2 inches high, 5½ inches wide and 7¼ inches deep!

MICROCOMPUTER CONTROL: Gives you the most advanced operating features available.

UP TO 11 NONSTANDARD SPLITS: **COMPARE** this with other units!

20 CHANNELS OF MEMORY IN TWO SEPARATE BANKS: Retains frequency, offset information, PL tone frequency.

DUAL MEMORY SCAN: Scan memory banks separately or together. **ALL** memory channels are tunable independently. **COMPARE!**

MEMORY SCAN LOCKOUT: Allows you to skip over channels you don't want to scan.

TWO RANGES OF PROGRAMMABLE BAND SCANNING: Limits are quickly reset. Scan ranges separately or together with independently selective steps in each range. **COMPARE!**

BUSY SCAN AND DELAY SCAN: Busy scan stops on an occupied channel. Delay scan provides automatic auto-resume.

DISCRIMINATOR CENTERING (AZDEN EXCLUSIVE PATENT): Always stops on frequency desired when scanning.

PRIORITY MEMORY AND ALERT: Unit constantly monitors one memory channel for signals, alerting you when channel is occupied.

LITHIUM BATTERY BACKUP: Memory information can be stored for up to 5 years even if power is removed.

FREQUENCY REVERSE: Allows you to listen to repeater input frequency.

ILLUMINATED KEYBOARD WITH ACQUISITION TONE: Keys are easily seen in the dark, and actuation is positively verified audibly.

CRISP, BACKLIGHTED LCD DISPLAY: Easily read no matter what the lighting conditions!

DIGITAL S/R/F METER: Shows incoming signal strength and relative transmitter power.

MULTI-FUNCTION INDICATOR: Shows a variety of operating parameters on the display.

FULL 16-KEY TOUCHTONE PAD: Keyboard functions as auto-patch when transmitting.

MICROPHONE CONTROLS: Up/down frequency control and priority channel recall.

PL TONE GENERATOR BUILT IN: Instantly program any of the standard PL frequencies into the microcomputer. **COMPARE!**

TRUE FM, NOT PHASE MODULATION: Unsurpassed intelligibility and audio fidelity. **COMPARE!**

HIGH/LOW POWER: Select 25 watts or 5 watts output — fully adjustable.

SUPERIOR RECEIVER: Sensitivity is better than 0.15 microvolt for 20-db quieting. Commercial-grade design assures optimum dynamic range and noise suppression. **COMPARE!**

DIRECT FREQUENCY ENTRY: Streamlines channel selection and programming.

OTHER FEATURES: Rugged dynamic microphone, built-in speaker, mobile mounting bracket, remote speaker jack, and all cords, plugs, fuses and hardware are included.

EXCLUSIVE DISTRIBUTOR: DEALER INQUIRIES INVITED FOR YOUR NEAREST DEALER OR TO ORDER

AMATEUR-WHOLESALE ELECTRONICS TOLL FREE...800-327-3102

46 Greensboro Highway, Watkinsville, Georgia 30677 Telephone (404) 769-8706 Telex: 4930709 ITT

MANUFACTURER:

JAPAN PIEZO CO., LTD.

1-12-17 Kamirenjaku, Mitaka, Tokyo, 181 Japan

Telex: 781-2822452



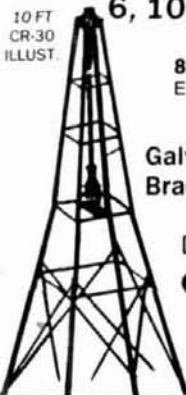


Creative Design Co., Ltd.

ROOF TOWERS!

A size to fit your needs
6, 10, or 15 ft.

10 FT
CR-30
ILLUST.



800-255-7020
Excluding California

Galvanized Steel
Bracing and Hardware

Dist. by ✓ 217

ORION HI-TECH

P.O. Box 8771,
Calabasas, CA.
91302
(213) 663-2541

zipper case tool kits

Hand Tool Industries has introduced a full line of tool kits for service, installation and maintenance technicians and engineers servicing electronic equipment. This full line is in addition to the complete selection of attache-type tool kits also offered by Hand Tool Industries.

Many of the kits are engineered for a specific electronic application, such as office machines, or telephone equipment. However, several are designed to handle multi-purpose service needs, such as the HTK-30, which provides the engineer or technician a variety of tools with which to work on copiers, drives, computers, and varied similar type electronic equipment.

Full details on each zipper kit and case, plus all the attached kits and cases, may be obtained by contacting Hand Tool Industries, Inc., Department ZC, 1933 Lake Street, Kent, Ohio 44240.

Circle #312 on Reader Service Card.

required signal level for normal operation is 0.5 volts peak-to-peak at 750 Hz.

This device (and its technical rationale) was described in two *ham radio* articles: "Carrier-Activated CW Reception Limiter" (September, 1985) and "Advanced CW Processor" (December, 1986). For further details, contact Hildreth Engineering Corporation, P.O. Box 60003, Sunnyvale, California 94088.

Circle #314 on Reader Service Card.

hf base station transceiver

Incorporating advanced new features, the ICOM IC-761 measures approximately 17 x 6 x 15 inches, and is conservatively rated at 100 watts output on CW, SSB, FSK, and SSTV. The transmitters' 28-volt power amplifier uses two husky 2SC2904's operating in push-pull. An internal whisper-quiet cooling fan and large heat sink are included for continuous 100-percent duty cycle operation.

The IC-761 also includes a built-in switching-type ac power supply plus a built-in automatic antenna tuner. The tuner is capable of matching a wide range of impedances from 16 to 150 ohms.



The IC-761's receiver continuously tunes from 100 kHz through 30 MHz, with sensitivity exceeding 0.15 microvolts. The receiver is a triple-conversion, superheterodyne, featuring a low noise, direct-feed mixer circuit. Its dynamic range is 105 dB, with a selectable AGC action.

Receiver performance is further enhanced with passband tuning, i-f shift, i-f notch, and a dual-width adjustable-level noise blanker. Frequencies may be selected via the main tuning knob or entered from the front keypad or from a computer with the ICOM "CI-V" interface kit. Thirty-two memory channels are available with direct memory channel input to VFO "A" or "B" for semi-duplex or split-band operation.

Special CW features include a built-in electronic keyer and a steep-skirted narrow CW filter. CW and RTTY selectivity is 500 Hz at 6 dB and 1,000 Hz at 60 dB. The audio notch null is greater than 45 dB. Semi and full break-in keying is rated to 60 WPM.

The IC-761 carries a one-year warranty from the date of purchase, with factory support from four regional service centers located in Atlanta, Georgia; Bellevue, Washington; Irving, Texas; and Vancouver, British Columbia.

For further information, contact ICOM America, Inc., 2380 116 Avenue N.E., P.O. Box C-90029, Bellevue, Washington 98009-9029.

Circle #315 on Reader Service Card.

automatic modulation meter

CT Systems' new fully automatic Modulation Meter, Model 4101, was designed to simplify am and fm modulation testing. Already in use in both field environments and manufacturing facilities, its simple pushbutton switches allow for front-panel selection of function, meter range, filter and de-emphasis.

Automatic measurements can be made from 1.5 MHz to 2.0 GHz of fm deviation to 100 kHz and a-m modulation to 100 percent. Input levels from 3 mv to 1 v, selectable de-emphasis of 50, 75, or 750 μ seconds. Both i-f and a-f outputs are standard.

Priced at \$1395, the 4101 Modulation Meter has a large easy-to-read meter, three selectable filters and is available with a rechargeable battery option. For information, contact CT Systems, Inc., 5245 Hornet Avenue, Beech Grove, Indiana 46107-0470.

Circle #313 on Reader Service Card.

Model 12 CW processor

Much more than just a good filter, Don Hildreth's Model 12 CW processor provides a synergistic sequence including a 4th-order Butterworth offset first filter, a selectable prelimiter, an 8th-order Butterworth cascade linear filter, a two-stage carrier-activated limiter system and a power amplifier.

Selection of these elements can provide S/N enhancement and impulse noise suppression (much beyond a simple limiter), and ringing suppression. It can even handle multiple woodpecker interference and short-duration atmospherics. Output power is up to 2 watts of audio into a 4- to 8-ohm speaker.

The input requirement to the unit is from +13 to +15 volts dc at a nominal 0.3 amps. Operation may be obtained with +12 volts, but with reduced audio power. Input impedance is 2.2 k resistive, to allow driving the unit from either a receiver's speaker or headset port. The maxi-



CONTACT YOUR DEALER

FOR MORE INFORMATION

Amateur Radio Baluns-
Traps-Remote Coaxial Switches

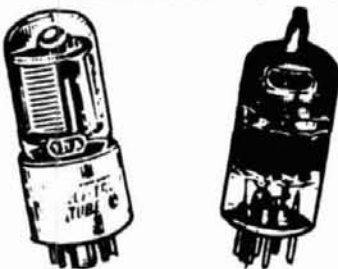
Or Write To:

UNADILLA Div. of ANTENNA'S ETC.

P.O. Box 215 BV ANDOVER, MA. 01810

617-475-7831 ✓ 218

7 MILLION TUBES



FREE CATALOG

Includes all Current, Obsolete, Antique, Hard-To-Find Receiving, Broadcast, Industrial, Radio/TV types. **LOWEST PRICES**, Major Brands, In Stock.

UNITY Electronics Dept. H

P.O. Box 213

Elizabeth, NJ 07206 ✓ 219

OPTOelectronics inc

NEW POCKET SIZE

SIZE: 4" H x 3.5" W x 1" D
MADE IN USA

\$99⁹⁵ - \$150⁰⁰

FREQUENCY COUNTERS TO 1.3 GHz

8 LED DIGITS • 2 GATE TIMES
ANODIZED ALUMINUM CABINET
INTERNAL NI-CAD BATTERIES INCLUDED
AC ADAPTER/CHARGER INCLUDED

EXCELLENT SENSITIVITY
& ACCURACY

AC-DC • PORTABLE
OPERATION



#AC-1200
AC ADAPTER
CHARGER

#1200H 1.2 GHz

Small enough to fit into a shirt pocket, our new 1.2 GHz and 1.3 GHz, 8 digit frequency counters are not toys! They can actually out perform units many times their size and price! Included are rechargeable Ni-Cad batteries installed inside the unit for hours of portable, cordless operation. The batteries are easily recharged using the AC adapter/charger supplied with the unit.

The excellent sensitivity of the 1200H makes it ideal for use with the telescoping RF pick-up antenna; accurately and easily measure transmit frequencies from handheld, fixed, or mobile radios such as: Police, firefighters, Ham, taxi, car telephone, aircraft, marine, etc. May be used for counter surveillance, locating hidden "bug" transmitters. Use with grid dip oscillator when designing and tuning antennas. May be used with a probe for measuring clock frequencies in computers, various digital circuitry or oscillators. Can be built into transmitters, signal generators and other devices to accurately monitor frequency.

The size, price and performance of these new instruments make them indispensable for technicians, engineers, schools, Hams, CBers, electronic hobbyists, short wave listeners, law enforcement personnel and many others.

STOCK NO:

#1200HKC	Model 1200H in kit form, 1-1200 MHz counter complete including all parts, cabinet, Ni-Cad batteries, AC adapter-battery charger and instructions	\$ 99.95
#1200HC	Model 1200H factory assembled 1-1200 MHz counter, tested and calibrated, complete including Ni-Cad batteries and AC adapter/battery charger	\$137.50
#1300HC	Model 1300H factory assembled 1-1300 MHz counter, tested and calibrated, complete including Ni-Cad batteries and AC adapter/battery charger	\$150.00

ACCESSORIES:

#TA-100S	Telescoping RF pick-up antenna with BNC connector	\$12.00
#P-100	Probe, direct connection 50 ohm, BNC connector	\$18.00
#CC-70	Carrying case, black vinyl with zipper opening. Will hold a counter and accessories	\$10.00

✓ 220

FLA (305) 771-2050

ORDER FACTORY DIRECT
1-800-327-5912



AVAILABLE NOW!



OPTOelectronics inc
5821 N.E. 14th Avenue
Ft. Lauderdale, Florida 33334

Orders to US and Canada add 5% of total (\$2 min., \$10 max)
Florida residents add 5% sales tax. COD fee \$2.



1.3 GHz
#1300H

HAM MART

Ham Radio's guide to help you find your local

California

A-TECH ELECTRONICS
1033 HOLLYWOOD WAY
BURBANK, CA 91505
(818) 845-9203
New Ham Store and Ready to Make a Deal!

JUN'S ELECTRONICS
3919 SEPULVEDA BLVD.
CULVER CITY, CA 90230
213-390-8003
800-882-1343 Trades
Habla Espanol

Colorado

COLORADO COMM CENTER
525 EAST 70th AVE.
SUITE ONE WEST
DENVER, CO 80229
(303) 288-7373
(800) 227-7373
Stocking all major lines
Kenwood Yaesu, Encomm, ICOM

Connecticut

HATRY ELECTRONICS
500 LEDYARD ST. (SOUTH)
HARTFORD, CT 06114
203-527-1881
Call today. Friendly one-stop shopping
at prices you can afford.

Delaware

AMATEUR & ADVANCED COMMUNICATIONS
3208 CONCORD PIKE
WILMINGTON, DE 19803
(302) 478-2757
Delaware's Friendliest Ham Store.

DELAWARE AMATEUR SUPPLY
71 MEADOW ROAD
NEW CASTLE, DE 19720
302-328-7728
800-441-7008
Icom, Ten-Tec, Microlog, Yaesu,
Kenwood, Santec, KDK, and more.
One mile off I-95, no sales tax.

Florida

AMATEUR ELECTRONIC SUPPLY
1898 DREW STREET
CLEARWATER, FL 33575
813-461-4267
Clearwater Branch
West Coast's only full service
Amateur Radio Store.
Hours M-F 9-5:30, Sat. 9-3

AMATEUR ELECTRONIC SUPPLY
621 COMMONWEALTH AVE.
ORLANDO, FL 32803
305-894-3238
Fla. Wats: 1 (800) 432-9424
Outside Fla: 1 (800) 327-1917
Hours M-F 9-5:30, Sat. 9-3

Georgia

DOC'S COMMUNICATIONS
702 CHICKAMAUGA AVENUE
ROSSVILLE, GA 30741
(404) 866-2302 / 861-5610
ICOM, Yaesu, Kenwood, Bird...
9AM-5:30PM
We service what we sell.

Hawaii

HONOLULU ELECTRONICS
819 KEEAUMOKU STREET
HONOLULU, HI 96814
(808) 949-5564
Kenwood, ICOM, Yaesu, Hy-Gain,
Cushcraft, AEA, KLM, Tri-Ex Towers,
Fluke, Belden, Astron, etc.

Idaho

ROSS DISTRIBUTING COMPANY
78 SOUTH STATE STREET
PRESTON, ID 83263
(208) 852-0830
M 9-2; T-F 9-6; S 9-2
Stock All Major Brands
Over 7000 Ham Related Items on
Hand

Illinois

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
312-631-5181
Hours: 9:30-5:30 Mon, Tu, Wed & Fri;
9:30-8:00 Thurs; 9:00-3:00 Sat.

Indiana

THE HAM STATION
220 N. FULTON AVE.
EVANSVILLE, IN 47710
812-422-0231
Discount prices on Ten-Tec, Cubic,
Hy-Gain, MFJ, Azden, Kantronics,
Santec and others.
SASE for New & Used Equipment List.

Maryland

MARYLAND RADIO CENTER
8576 LAURELDALE DRIVE
LAUREL, MD 20707
301-725-1212
Kenwood, Ten-Tec, Alinco, Azden. Full
service dealer.
M-F 10-7 SAT 9-5

Massachusetts

TEL-COM, INC.
675 GREAT ROAD, RTE. 119
LITTLETON, MA 01460
617-486-3400
617-486-3040
The Ham Store of New England
You Can Rely On.

Michigan

ATLANTIC SOLAR POWER/ENCON
(SINCE 1979)
37279 W. SIX MILE RD.
LIVONIA, MI 48152
(313) 591-7745
Solar Electric Power for Repeaters,
Ham Shacks, Packet Radio.
Call Paul, WD8AHO

Minnesota

TNT RADIO SALES
4124 WEST BROADWAY
ROBBINSDALE, MN 55422 (MPLS./ST.
PAUL)
TOLL FREE: (800) 328-0250
In Minn: (612) 535-5050
M-F 9 AM-6 PM
Sat 9 AM-5 PM
Ameritron, Bencher, Butternut, ICOM,
Kenwood

Missouri

MISSOURI RADIO CENTER
102 NW BUSINESS PARK LANE
KANSAS CITY, MO 64150
(800) 821-7323
Missouri: (816) 741-8118
ICOM, Kenwood, Yaesu
Same day service, low prices.

Nevada

AMATEUR ELECTRONIC SUPPLY
1072 N. RANCHO DRIVE
LAS VEGAS, NV 89106
702-647-3114
Dale Porray "Squeak," AD7K
Outside Nev: 1 (800) 634-6227
Hours M-F 9-5:30, Sat. 9-3

Dealers: *YOU SHOULD BE HERE TOO!*
Contact Ham Radio now for complete details.

Amateur Radio Dealer

New Hampshire

RIVENDELL ELECTRONICS
8 LONDONDERRY ROAD
DERRY, N. H. 03038
603-434-5371
Hours M-S 10-5; THURS 10-7
Closed Sun/Holidays

New Jersey

ABARIS SYSTEMS
276 ORIENTAL PLACE
LYNDHURST, NJ 07071
201-939-0015
Don WB2GPU
Astatic, Azden, B&W, Butternut, Larsen,
Mirage/KLM, Kenpro, Nye, Santec,
THL, and many others.
M-F 10 am-9 pm
SAT 9 am-7 pm
VISA/MC

KJI ELECTRONICS
66 SKYTOP ROAD
CEDAR GROVE, NJ 07009
(201) 239-4389
Gene K2KJI
Maryann K2RVH
Distributor of: KLM, Mirage, ICOM, Lar-
sen, Lunar, Astron. Wholesale - retail.

New York

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, NY 10012
212-925-7000
New York City's Largest Full Service
Ham and Commercial Radio Store.

VHF COMMUNICATIONS
915 NORTH MAIN STREET
JAMESTOWN, NY 14701
716-664-6345
Call after 7 PM and save! Supplying all
of your Amateur needs. Featuring ICOM
"The World System." Western New
York's finest Amateur dealer.

North Carolina

F & M ELECTRONICS
3520 Rockingham Road
Greensboro, NC 27407
1-919-299-3437
9AM to 7PM Closed Monday
ICOM our speciality — Sales & Service

Ohio

AMATEUR ELECTRONIC SUPPLY
28940 EUCLID AVE.
WICKLIFFE, OH 44092 (Cleveland Area)
216-585-7388
Ohio Wats: 1 (800) 362-0290
Outside Ohio: 1 (800) 321-3594
Hours M-F 9-5:30, Sat. 9-3

DEBCO ELECTRONICS, INC.
3931 EDWARDS RD.
CINCINNATI, OHIO 45209
(513) 531-4499
Mon-Sat 10AM-9PM
Sun 12-6PM
We buy and sell all types of electronic
parts.

UNIVERSAL AMATEUR RADIO, INC.
1280 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH
43068
614-866-4267
Featuring Kenwood, Yaesu, Icom,
and other fine gear. Factory author-
ized sales and service. Shortwave
specialists. Near I-270 and airport.

Pennsylvania

**HAMTRONICS,
DIV. OF TREVOSE ELECTRONICS**
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same Location for over 30 Years

LaRUE ELECTRONICS
1112 GRANDVIEW STREET
SCRANTON, PENNSYLVANIA 18509
717-343-2124
ICOM, Bird, Cushcraft, Beckman,
Larsen, Amphenol, Astron, Belden,
Antenna Specialists, W2AU/W2VS,
Tokyo Hy-Power Labs, WELZ, Daiwa,
Sony, Saxton, Vibroplex, Weller.

Tennessee

MEMPHIS AMATEUR ELECTRONICS
1465 WELLS STATION ROAD
MEMPHIS, TN 38108
Call Toll Free: 1-800-238-6168
M-F 9-5; Sat 9-12
Kenwood, ICOM, Ten-Tec, Cushcraft,
Hy-Gain, Hustler, Larsen, AEA,
Mirage, Ameritron, etc.

Texas

MADISON ELECTRONICS SUPPLY
3621 FANNIN
HOUSTON, TX 77004
713-520-7300
Christmas?? Now??

KENNEDY ASSOCIATES
AMATEUR RADIO DIVISION
5707A MOBUD
SAN ANTONIO, TX 78238
Stocking all major lines. San Antonio's
Ham Store. Great Prices — Great
Service. Factory authorized sales and
service.
Hours: M-F 10-6; SAT 9-3

MISSION COMMUNICATIONS
11903 ALEIF CLODINE
SUITE 500 (CORNER HARWIN &
KIRKWOOD)
HOUSTON, TEXAS 77082
(713) 879-7764
Now in Southwest Houston—full line
of equipment. All the essentials and
extras for the "ham."

Wisconsin

AMATEUR ELECTRONIC SUPPLY
4828 W. FOND DU LAC AVE.
MILWAUKEE, WI 53216
414-442-4200
Wisc. Wats: 1 (800) 242-5195
Outside Wisc: 1 (800) 558-0411
M-F 9-5:30 Sat 9-3

Invitation to Authors

ham radio welcomes manuscripts
from readers. If you have an idea for
an article you'd like to have considered
for publication, send for a free copy
of the *ham radio* Author's Guide.
Address your request to *ham radio*,
Greenville, New Hampshire 03048
(SASE appreciated).

Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria Karin Ueber Postfach 2454 D-7850 Loerrach West Germany	Canada Send orders to Ham Radio Magazine Greenville, NH 03048 USA Prices in Canadian funds 1 yr \$41.85, 2 yrs \$74.25 3 yrs \$99.90
Ham Radio Belgium Sterehouse Brusselsesteenweg 416 B-9218 Gent Belgium	Ham Radio Italy Via Manigo 15 I-20134 Milano Italy
Ham Radio Holland Postbus 413 NL-7800 Ar Emmen Holland	Ham Radio Switzerland Karin Ueber Postfach 2454 D-7850 Loerrach West Germany
Ham Radio Europe Box 2084 S-194 02 Upplands Vasby Sweden	Ham Radio England c/o R S G B Lambda House Crabborne Road Potters Bar Herts EN6 3JW England
Ham Radio France SM Electronic 20 bis, Ave des Clairons F-89000 Auxerre France	
Ham Radio Germany Karin Ueber Postfach 2454 D-7850 Loerrach West Germany	

2x4Z BASE REPEATER ANTENNA

THE HIGHEST GAIN DUAL BAND BASE/REPEATER ANTENNA

HIGH POWER 200 WATTS

FREQUENCY: BROAD BAND
140-170 MHZ
410-470 MHZ

GAIN:
VHF - 8.2dB
UHF - 11.5dB
VSWR - 1.-1.2 or less

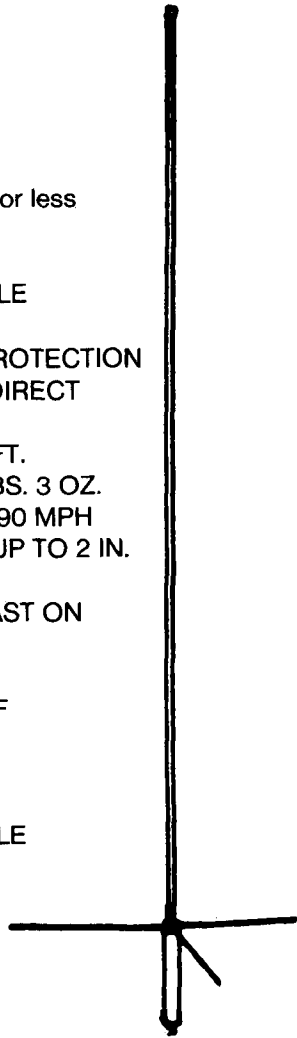
CONNECTOR:
N TYPE FEMALE

LIGHTNING PROTECTION
GROUNDED DIRECT

LENGTH: 16 FT.
WEIGHT: 5 LBS. 3 OZ.
WIND LOAD: 90 MPH
MOUNTING: UP TO 2 IN.
MAST
CAN SIMULCAST ON
BOTH BANDS

WATERPROOF
CONNECTING
JOINTS

UPS SHIPPABLE



AMATEUR SPECIAL



1275 NORTH GROVE ST.
ANAHEIM, CALIF. 92806
(714) 630-4541
CABLE: NATCOLGLZ
FAX (714) 630-7024

✓ 221

WISCONSIN: July 18. The South Milwaukee ARC will hold its annual SWAPFEST, American Legion Post 434, 9327 South Shepard Avenue, Oak Creek. 7 AM to 3 PM. Admission \$3.00. VE exams, picnicking, refreshments. Free overnight camping on grounds. Talk in on 146.94. For details: The South Milwaukee ARC, POB 102, South Milwaukee, WI 53172-0102.

MASSACHUSETTS: July 24, 25, 26. The 2nd ARRL "Heavy Hitters Hamfest", Topsfield Fairgrounds, US Rt 1, Topsfield. Indoor/outdoor flea market, Contests, fox hunts, packet radio and RTTY mailbox demos. License exams, alternative activities and more. Free camping Friday and Saturday nights for tents and SC RV's. Nearby hotels. Advance tickets \$3.00. \$4.00/door. Children with adults admitted free. For more information Russ Corkum, WA1TTV, 21 Thorndike Street, Arlington, MA 02174.

NORTHWEST USA: July 31, August 1 and 2. The 55th annual Wyoming, Idaho, Montana, Utah Hamfest, Virginian Lodge, Jackson Hole, Wyoming. Friday evening Cowboy Cookout, seminars, forums, speakers and Sunday Awards presentation. Non-ham activities. Nearby shopping. And Grand Teton and Yellowstone National Parks. QCWA Hospitality Suite. Free swap tables. Tickets \$10/door or \$8/advance by July 20. RV parking next door at A-1 Campground. For registration/ information contact: WIMU87 Hamfest, c/o Cheryl Ransom, KA7QOE, HC36-205, Riverton, WY 82501. (307) 856-1811.

PENNSYLVANIA: August 9. The Mid-Atlantic ARC announces its annual Hamfest, Bucks County Drive-in Theater, Rt 611, Warrington. 8 AM to 3 PM rain or shine. Admission \$3.00. Tailgating \$2.00 extra. Setups 7 AM. Bring own table. Talk in on WB3JOE/R, 147.66/.06 or 146.52. For information write MARC, 203 Second Avenue, Broomall, PA 19008 or call John Bartholomew, WB3ELA (215) 356-7197.

ILLINOIS: August 9. Hamfesters Radio Club, celebrating its 54th year of Amateur Radio service, is having its 53rd annual Hamfest, Santa Fe Park, 91st and Wolf Road, Willow Springs (near Chicago). Donation \$3/advance; \$4/door. For information call: (313)403-1043.

INDIANA: July 11 and 12. The 17th annual State ARRL Convention and Hamfest, Marion County Fairgrounds, Indianapolis. Gates open 6 AM both days. Gate fee \$5. Children under 12 free. Food available on grounds. Nearby motels and restaurants. Flea market, dealer displays, tech forums. Camping on grounds with free hookups provided by Hamfest Assn. For info on flea market space: (317) 356-4451. For info on commercial space: (317) 745-6389.

WISCONSIN: July 18. The South Milwaukee ARC will hold its annual Swapfest, American Legion Post 434, 9327 South Shepard Avenue, Oak Creek. 7 AM to 3 PM. Parking, picnicking, food, refreshments and free overnight camping available on grounds. Admission \$3.00 includes "happy time" with free beverages. License exams. Packet meeting. For details write South Milwaukee ARC, PO Box 102, South Milwaukee, WI 53172-0102.

WEST VIRGINIA: July 19. The 9th annual TSRAC Wheeling Hamfest/Computer Fair, Wheeling Park. 9 AM to 4 PM. WV's largest. Dealers welcome 30,000 square feet under roof; 5 acres flea market. Family activities at Park. Admission \$3.00 in advance; \$4.00 at door. To reserve space contact: Carl Williams, WDBPPS, 9 East High St, Flushing, OH 43977. For tickets: TSRAC, Box 240, RD 1, Adena, OH 43901 (614) 546-3930.

WASHINGTON: August 22-23. The Radio Club of Tacoma presents Hamfair '87 and the ARRL Northwestern Division Convention, Pacific Lutheran University, Tacoma. Friday evening entertainment. Doors open 9 AM August 22. Registration \$5.00 til August 12. \$6.00 at the door. Banquet \$10.00 by August 12. RV spaces \$2.00. No hookups. Technical seminars, forums, flea market (tables \$18/6') non-ham activities, VE exams all classes. For reservations and/or flea market tables write Al Wittich, KA7SBJ, 3832 Gay Rd E, Tacoma, WA 98443 or call Bill Morgan, W7GRP (206) 531-3821 or Marion O'Neal, WB7SQU (206) 838-3126.

INDIANA: August 9. The 8th annual Grant County ARC Hamfest, 4-H Fairgrounds, Marion. Doors open 8 AM. Refreshments, free parking, VE exams and more. Donation \$3.00/advance. \$4.00/gate. Inside tables \$4.00. Flea market space \$2.00. For information or tickets SASE to WB9EAP, Brooks Clark, 2202 South Boots Street, Marion, IN 46953.

NEW YORK: July 12. Genesee Radio Amateurs annual Batavia Hamfest, Alexander Firemen's Grounds, Rt 98, Alexander. 6 AM to 5 PM. Admission \$3 advance, \$4 at door. Breakfast, flea market, programs, chicken BBQ, VEC exams, free camping. Talk in on 146.52 and 144.71/145.31. For information write GRAM, POB 572, Batavia, NY 14020 or call Dave Harms, KC2RF (716) 342-6770.

1987 "BLOSSOMLAND BLAST" Sunday, September 20, 1987. Write "BLAST" PO Box 175, St. Joseph, MI 49085.

OPERATING EVENTS

"Things to do . . ."

July 12: Eric NF0Q and Allan KA8JN will operate NF0Q/8 at Mt. Clemens, MI from 1200Z to 2100Z to commemorate the 200th Anniversary of the Northwest Ordinance of 1787. Primary freqs 7250 and 14325. Secondary 21350, 28410 and Detroit area 2 meter repeaters. For certificates send large SASE to Erick Koch, NF0Q, 2805 Westminister, St. Charles, MO 63301.

July 5-12: The Stateline ARC will operate station KT5I to celebrate the 1987 National Soaring Championships from the new National Headquarters of the National Soaring Society, Hobbs, NM. 10-80 meters. For certificate send QSL and contact number to State Line ARC, KT5I, POB 1423, Hobbs, NM 88240.

July 14: The Valley ARA will sponsor a special events station at the Statler Brothers' "Happy Birthday USA Celebration" in Staunton, VA. 8 AM to 8:30 PM. 14250, 3850 and 7230. For special certificate SASE to N4ICT, POB 1091, Staunton, VA 24401.

July 18-19: The Bolingbrook Amateur Radio Society in conjunction with the City of Naperville, Illinois, will be operating a Special Event Station, KE9DE, to commemorate the Revolutionary War. 1400Z to 2100Z. 14.300, 7.250. For certificate send QSL card and No. 10 SASE to Special Event Chairman, Rich Wayne, KE9DE, POB 495, Naperville, IL 60566-0495.

July 7-9: Aboard USS MISSOURI (BB-63). The Naval Postgraduate School ARC (K6LY) will operate a special event station during Fleet Week Monterey in conjunction with celebration commemorating the Gret White Fleet journey of 1907-09. 1700Z-0100Z. Lower 50 kHz of 20 and 15 meters and Novice portion of 10m. For a commemorative QSL card send your QSL card and SASE to NK6H, 96 Cuesta Vista Drive, Monterey, CA 93940.

July 25-26: The Eastern Michigan ARC will operate K8EPV to commemorate the 62nd Port Huron to Mackinac Island Yacht Race. 1400Z to 020Z each day. For large certificate SASE with QSL to K8EPV, 654 Georgia, Marysville, MI 48040.

July 11-12: The Holmdel ARC will operate K2DR to commemorate the 25th anniversary of the launching of the TELSTAR communications satellite. 1500Z to 2200Z July 11 and 1500Z to 2000Z July 12. 20, 40, 80m General phone bands. Lower 25 kHz of Novice 10m phone band. For certificate send QSL and SASE to Holmdel ARC, POB 205, Holmdel, NJ 07733.

July 12: The Buzzard's Roost Repeater Club will operate KC0DA from downtown Petersburg, Nebraska to help this community celebrate its centennial. QSL with SASE to KC0DA, Larry Lehmann, 706 West Fairview Avenue, Albion, NE 68620.

July 26: East Aurora "Racing Day" special event station W2QFC operated by the Pioneer Radio Operators Society (PROS) from the Village Park, once the trotting horse mecca of the world. 10 AM to 5 PM EDST. 3935, 7235, 14235. For a special QSL SASE to W2QFC 308 Parkdale Avenue, East Aurora, NY 14052.

CHARGE
YOUR CLASSIFIED ADS
to your MC or VISA, write or call
HAM RADIO MAGAZINE
Greenville, NH 03048
(603) 878-1441

short circuit

real coax

Two errors appeared in Forrest Gehrke's article, "Real Coax" (April, 1987, page 8). In the lower left-hand column of page 12, dB = 0.1151 neper = log_e should be corrected to read as follows:

$$0.1151 \left(\frac{\text{Value}}{\text{in dB}} \right) = \left(\frac{\text{Value}}{\text{in nepers}} \right)$$

$$= \log_e \sqrt{P1/P2}$$

or, if you wish,

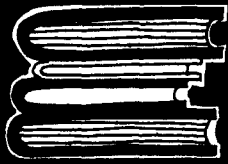
$$.1151 \text{ dB} = \text{nepers} = \log_e \sqrt{P1/P2}$$

At the top of the right-hand column,

$$10^{\frac{\text{dB}}{10}} = \sqrt{P1/P2}$$

should be corrected to read:

$$10^{\frac{\text{dB}}{10}} = P1/P2$$



ELMER'S NOTEBOOK

Tom McMullen, W1SL

an introduction to digital communications

I'll explore some of the **hows** and **whys** of digital communications in this month's column. But first, I'd like to report on a wonderful Elmer whose work was just called to my attention: Glenn Shaw, W6NI, of Rockport, Texas.

It seems that Glenn has made it a personal goal to be the first contact for new Amateurs. He's been at this for 20 years or so, and has made a lot of friends along the way. Just think how much easier your first contact would have been if you'd known that the guy at the other end of the path was patient and understanding — and wasn't going to laugh at your faltering attempts at sending call letters, QTH, signal reports, name, and all that stuff that's so hard to do on your first contact!

Several of Glenn's "firsts" have gone on to earn Extra class licenses. Many keep in touch by letter or by radio. Glenn has even developed a special certificate to grace the wall of their shacks.

Great work, Glenn, and may your tribe increase! (And thanks to KA5BWL for calling Glenn to my attention.)

the digital business

Now, on to this digital business. It will be many, many license-renewal periods before this mode begins to seriously crowd the bands, but it's an important part of the communications world, and it will become even more important and widespread than it is now. So, don't throw away that key or microphone just yet, but make room for a keyboard alongside.

We've come to think of digital as being associated with computers, but that's not all there is to it. Radioteletype (RTTY) has been around — and on the Amateur bands — for ages. Audio-frequency-shift keying (AFSK) was used on the 11-meter band (when it was still an Amateur band) in early days of RTTY, and is still widely used on VHF and UHF. After 1953, when the FCC allowed FSK to be used on the Amateur hf bands, the number of RTTY stations that could be heard "RYing"* on the air increased monthly. *That* was digital communications, even though most Amateurs didn't think of it as such. It was — and is — information propagated by means of pulses, and the pulses were derived from mechanical contacts in a mechanism activated by a keyboard or by contacts that "read" the holes in a punched paper tape.

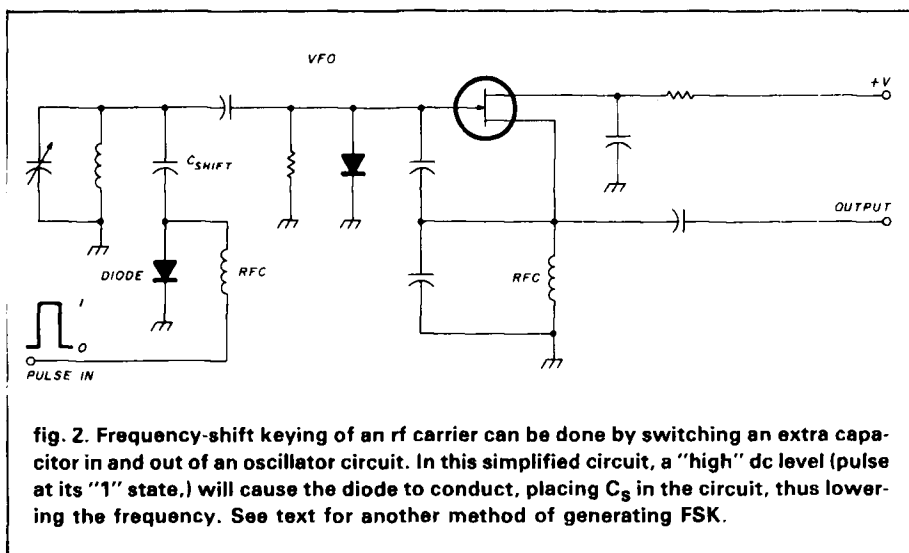
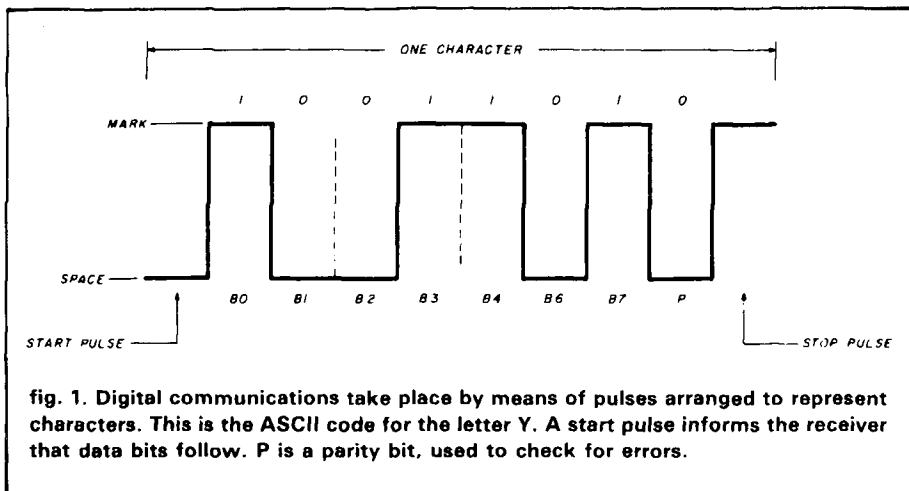
Pulses have two levels, or states, to their waveform: *high* and *low*. Several conventions are used to describe these states: for example, *on and off*, *1 and 0*, *plus and minus*, *mark and space*, and so forth. It's basically a matter of changing the dc voltage level from one resting value to another, and the change from one to the other is rather abrupt. Individually, these pulses don't do much for us — but groups of them can be put together in a well-defined arrangement, or code, to convey information. American RTTY employs a code called Baudot (which rhymes with "doe"); the British use an almost identical arrangement they call the Murray code. The RTTY system

*An early test signal, sent ad infinitum to let people know you'd mastered the intricacies of getting a system up and running.

**However, the *suppressed carrier* remains at the same frequency. — Ed.

uses five pulses (called "bits") in various sequences that allow transmission of all the letters of the alphabet, numbers, some special functions such as ringing a bell, sending a carriage return and/or a line feed to the receiving system, and others, for a total of 64 characters.

A more modern type of code is called ASCII (from American Standard Code for Information Interchange, pronounced "askey"). This code has seven pulses, with the option of adding another for error-checking purposes (this eighth bit, or pulse, is called a "parity" bit). This allows a code table that includes all the letters, numbers, functions, and symbols you'll ever need, and some you probably won't. A sample of the pulse combinations for the letter Y is shown in **fig. 1**. ASCII tables abound in computer books, handbooks, and textbooks about data processing, so there's no need for me to repeat one here. However, when you do look at an ASCII table, note that it reads backwards compared with the drawing in **fig. 1**. Most tables list the bits in order of significance, with the most-significant bit at the left, as at the beginning of a word. **Figure 1** shows the sequence as it would be transmitted, with the least-significant bit (B0) first. If you have trouble with the notion of significance, look at the dollar amount of \$10,005; certainly the "1" is much more significant than the "5" — right? The drawing also shows what happens when two bits of the same polarity (1 or 0) occur together. The voltage doesn't return to its other state between pulses, but stays at the 1 or 0 value for a time duration equal to two bit lengths. **Figure 1** shows two zeros together and two ones together;



the dotted line merely illustrates that there are two bits there.

the bit connection

All this business about pulses and bits and ones and zeros is fine, but how do you apply them to a transceiver? Can you just hook the output of a keyboard to the microphone jack and start cranking out digital stuff? Well, no — not unless you have a very unusual transceiver. You'd get an awful lot of clicks from the fast transitions from 0 to 1 and back (plus an equal number of irate phone calls from your neighboring hams whose QSOs you were messing up).

Two basic methods of transmitting digital information are in use on the Amateur bands today: frequency-shift

keying (FSK) and audio-frequency-shift keying (AFSK).

FSK, as used on the hf bands, can be generated by either of two methods. One way is to change the frequency of an oscillator in response to a pulse, with a circuit such as the one shown in **fig. 2**. In this simplified diagram, a diode is in series with an extra capacitor across an oscillator coil. When the dc level at the anode end of the diode is at 1, the diode conducts, and the capacitor is "in," causing the frequency to be at its lowest value. When the pulse falls below the diode's conduction level (the pulse is at its "0" state), the capacitor is "out," and the oscillator frequency is higher. The difference between the two frequencies is called

"shift," and is usually 170 Hz in most applications. With proper design and careful attention to temperature compensation and mechanical stability, this is a very satisfactory system. For years direct FSK was the only system on the hf bands.

The increased availability of SSB equipment, and the frequency stability of these rigs, has brought forth another method of creating FSK for the digital modes. When you apply a pure sine wave to an SSB modulator, you generate a single-frequency rf carrier (that's how you tune up your SSB rig, isn't it?). Now, if you cause the audio frequency (sine wave) to change by the desired shift, the generated** rf carrier frequency is going to change right along with it, with the result that someone listening won't be able to tell the difference between this method and that described in the preceding paragraph: both produce a shift in the rf carrier frequency in response to the state of the modulating pulse.

The audio frequency can be made to shift by several methods: by using diodes or transistors to switch coil or capacitor values in and out of an oscillator circuit; by switching separate oscillator circuits in and out; or by using a microprocessor to synthesize the audio frequencies needed.

So, it all comes down to this: the "encoding" device — which can be a keyboard, a set of contacts in a mechanical arrangement, or a computer — must be hooked to either an hf transmitter (or transceiver) by means of a diode frequency-shift circuit or to the microphone input of an SSB rig when audio-frequency-shift is used to generate the carrier. For VHF and UHF fm equipment, straight AFSK is used, and audio tones can be applied directly to the microphone input (or sometimes to an auxiliary input circuit that doesn't need the high gain provided by most microphone circuits).

Most equipment used today includes some form of built-in modulator that translates the strictly dc, on/off pulses into something that a transmitter can work with. You might

The Professional Meter for Amateur Radio.



The standard of the electronics industry is setting a new standard for amateur radio use as well.

The Fluke 77 multimeter is ideal for testing and repairing any amateur radio gear. It's inexpensive, easy to use, and filled with professional features. Plus a full line of accessories let you measure high frequency, high voltage and current, and temperature. Made in the U.S.A. and backed by a 3-year warranty, the new Fluke 77 is the world's first handheld meter to combine analog and digital displays.

For a free brochure or the distributor nearest you, call toll-free **1-800-227-3800, ext. 229**. Or write John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206. Distributor programs available.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 73	FLUKE 75	FLUKE 77
\$79†	\$109†	\$145†
Analog/digital display	Analog/digital display	Analog/digital display
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA, diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	Touch-Hold™
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

† Suggested U.S. list price, effective January 2, 1987.



© 1987 Fluke

94 **7A** July 1987

✓ 228

MULTI BAND TRAP ANTENNAS



TRAP DIPOLES:

Model	Bands	Traps	Length	Price
D-42	10/15/20/40	2	55"	\$19.95
D-52	10/15/20/40/80	2	105"	64.95
D-56	10/15/20/40/80	6	82"	109.95
D-66	10/15/20/40/80/160	6	163"	129.95

TRAP VERTICALS - "SLOPERS":*

Model	Bands	Traps	Length	Price
VS-41	10/15/20/40	1	28"	44.95
VS-52	10/15/20/40/80	2	49"	59.95
VS-53	10/15/20/40/80	3	42"	69.95
VS-64	10/15/20/40/80/160	4	73"	89.95

*Can be used without traps
*Feed line can be buried if desired

*Permanent or Portable Use

ALL TRAP ANTENNAS are Ready to use - Factory assembled - Commercial Quality - Handle full power - Comes complete with: Deluxe Traps, Deluxe center connector, 14 ga Stranded CopperWeld ant. wire and End Insulators. Automatic Band Switching - Tuner usually never required - For all Transmitters, Receivers & Transceivers - For all class amateurs - One feedline works all bands - Instructions included - 10 day money back guarantee!

SINGLE BAND DIPOLES (Kit form):

Model	Band	Length	Price
D-15	15	22"	18.95
D-20	20	33"	19.95
D-40	40	66"	22.95
D-80	80/75	130"	25.95
D-160	160	260"	34.95

Includes assembly instructions, Deluxe center connector, 14 ga Stranded CopperWeld Antenna wire and End insulators.

COAX CABLE: (includes PL-259 connector on each end)

Type	Length	With antenna purchase	Separately
RG-58	50'	\$8.00	\$11.95
RG-58	90'	12.00	16.95

DELUXE CENTER CONNECTOR

- NO RUST! Brass Terminals
- NO Jumper Wires Used
- NO Soldering
- Built-in Lightning Arrestor
- With SO-239 Receptacle
- Handles Full Power
- Completely Sealed, Weatherproof
- Easy Element Adjustments
- Commercial Quality



CE-1
\$8.95

DELUXE ANTENNA TRAPS: Completely sealed & weatherproof - Solid brass terminals - Handles Full Power - NO jumpers - NO Soldering.

Instructions included.
For 4-band Dipole Ant. 40/20/15/10 \$36.00/pr.
For 5-band Dipole Ant. 80/40/20/15/10 \$38.00/pr.

ORDER DIRECT FROM FACTORY. All orders shipped US Postpaid. VISA/MC - give card #, Exp. date, Signature

SPI-RO MANUFACTURING, INC.

Dept. 103, P.O. Box 1538
Hendersonville, NC 28793

Dealer Inquiries Invited

✓ 225

AMATEUR RADIO MAIL LISTS

Self-stick 1x3 labels

- *** NEWLY LICENCED HAMS ***
- *** ALL NEW UPGRADES ***
- *** UPDATED EACH WEEK ***

Total List = 462,728 (ZIP sorted)
Price is 2.5 cents each (4-up Cheshire)

BUCKMASTER PUBLISHING
Mineral, Virginia 23117
703:894-5777

✓ 226



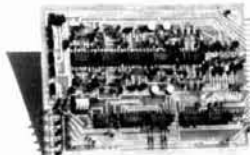
1-800-433-WIRE

FOR ALL AMATEUR WIRE & CABLE
Belden & Equivalent
(803) 895-4195 (SC & Ragchew)

CERTIFIED COMMUNICATIONS
PITTMAN ROAD, ROUTE 2, LANDRUM, SC 29356

✓ 227

THE MULTIPLE RECEIVER SOLUTION



4 Channel Signal-to-Noise Voter

- Expandable to 32 Channel by Just Adding Cards
- Continuous Voting
- LED Indicators of COR and Voted Signals
- Built-in Calibrator
- Remote Voted Indicators Pinned Out
- 4 1/2 x 6 Double Sided Gold Plated 44 Pin Card
- Remote Disable Inputs
- MORE

Built, tested and calibrated with manual

\$350.00

NEW PRODUCT

Telephone interface now available
For more information call or write:

HALL ELECTRONICS

Voter Department
815 E. Hudson Street
Columbus, Ohio 43211
(614) 261-8871

✓ 222

Light Weight/ High Strength ALUMINUM Tubing for Masts and Telescoping Elements



How many antennas have you seen ruined by the failure of the mast? If you are stacking antennas, or have a beam antenna, our Light Weight/High Strength Aluminum masts will increase the survivability of your antenna system. These masts are 67% lighter and 50% stronger than galvanized steel tubing. Example of weight difference: 1/4" wall x 2" OD x 24' long; AL, 39 lbs., Steel, 112 lbs.

Sizes available:

1-1/2" to 8" OD x 1/8" to 3/4" wall x 24' long
1/4" to 2" OD x .058" wall x 12' long (drawn for telescoping)

Club and volume discounts are offered. MC & VISA accepted.
For a complete stock/price list, please write or call.

Metal & Cable Corp., Inc.

(formerly Exmet, Inc.)
P.O. Box 117, 2170 E. Aurora Rd.

Twinsburg, Ohio 44087

(216) 425-8455

✓ 223

Become a DeVry VE

DeVry VE teams have the advantage of:

- Personalized service
- Quick Accreditation
- Free test generation software
- Out-of-pocket expense reimbursement
- Use of 800 number to communicate with the VEC
- Generating their own examinations

Contact: Jim Georgias, W9JUG
DeVry VEC

3300 No. Campbell Avenue
Chicago, IL 60618
(312) 929-8500

(800) 327-2444 (outside of Illinois)

even find it combined with a demodulator and called a *modem* (modulator-demodulator). Whatever it's called, it's connected between the keyboard and the transmitter.

Modern digital equipment available for Amateur use is designed to connect easily to most common transmitters or transceivers, and the manufacturer's instructions make it relatively simple to get a station on the air. However, it's best to read carefully and ask questions to be sure that the pieces can get along with each other (in high-tech language, this is called "compatibility").

other modes

Packet Radio — the fastest growing aspect of Amateur Radio today — is a special application of digital codes. There's also a system called AMTOR that really helps overcome errors caused by noise and fading. I'll cover these in one or more future issues. They're both fascinating modes of

communication, and once you understand what they can do and why, you'll enjoy untold hours of enjoyable operation. (If you enjoy "alphabet soup" such as RTTY, ASCII, SSB, and others you've seen in this column, wait 'till you get to Packet — with its DCEs, DTEs, layers, protocols, RS-232, CCITs, etc. You'll love it!)

10-meter prospects

While we're looking at the digital part of the new privileges, let's not forget the rf side of it all. Although the 10-meter band seems like never-never land at the moment, don't cross it off too quickly. There have been a few openings recently (March and April) where the other side of the world was booming in with "ham-in-the-next-block" signal strength, and some of the signals stayed for hours. As sunspot activity increases gradually over the next three to four years, propagation on 10 meters can only get better. Now's the time to get your new station

assembled, tested, fine tuned, and ready for the wall-to-wall DX that 10 meters offers in its better moods. This is a great time to try new skills and modes, when the band is usually dead for DX but provides superb interference-free local communications. So, all you Elmers out there, set up some skeds with your favorite Novices or Techs and help them practice the new techniques; when the world is accessible on 10 meters, they'll be ready to communicate. Meanwhile, if there happens to be a great opening to Europe, Africa, New Zealand, Australia, or the Philippines, they'll be there to enjoy it.

For a more thorough — yet still basic — discussion of digital communications, see *The Digital Novice* by Jim Grubbs, K9EI. Available from Ham Radio's Bookstore, Greenville, NH 03048 for \$9.95 plus \$3.50 shipping and handling. — Ed.

ham radio



"The RC-850 Repeater Controller ... still the leader of the pack!"

The RC-850 controller offers your group the most advanced repeater control technology available anywhere. Through ongoing hardware and software enhancements, even our first customers enjoy new features that keep it ahead of the pack. With the '850, your repeater becomes fully remotely programmable. From command codes to the repeater's operating schedule, virtually everything can be easily changed. Touch-Tone programming from your radio or the phone with synthesized voice readback, or programming from your home computer via modem or packet.

The autopatch supports local and radio-linked remote phone lines, extending your patch coverage to match your RF coverage. You don't even need a phone line at your site! The 250

autodial slots meet everyone's needs, with up to 35 digit storage for personal MCI/Sprint codes.

The easy-to-use mailbox lets you include phone numbers, times, or frequencies in messages. The controller is so smart, it'll leave you a message if you miss a reverse patch or an alarm.

Selective call capabilities range from CTCSS and two-tone to display paging, so you can always be available without having to listen. Voice response telemetry lets you remotely meter your site. Its continuous measurements with storage of updated min and max readings let you find out how cold it gets, how high the reflected power reads . . . and when.

Individual user access codes, with callsign ID, offer secure access to selected functions to completely prevent horseplay.

The industry's top-of-the-line controller, now better than ever, for *your* repeater.

acc advanced
computer
controls, inc.

2356 Walsh Avenue, Santa Clara, California 95051
(408) 727-3330

**PERFORMANCE
AND VALUE**
WITHOUT COMPROMISE

KRP-5000 REPEATER

Word is spreading fast—
"Nothing matches the KRP-5000
for total performance and value. Not GE, not even Motorola."

2 meters — 220 — 440

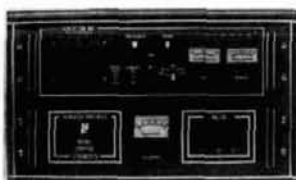
RF performance really counts in tough repeater environments, so the KRP-5000 receiver gives you 7 helical resonators, 12-poles of IF filtering, and a precise Schmitt trigger squelch with automatic threshold switching. The transmitter gives you clean TMOS FET power.

Enjoy high performance operation with: remote programmability, sequential tone paging, autopatch, reverse autopatch, 200-number autodial, remote squelch setting, status inputs, control outputs, and field-programmable Morse messages.

Call or write for the full performance story . . . and the super value price!

Micro Control Specialties
23 Elm Park, Groveland, MA 01834
(617) 372-3442
TELEX: 4932256 Kendecom
FAX: 6173737304

The first choice in
Transmitters - Receivers
Repeaters
Repeater Controllers
Power Amplifiers
Voice Mail Systems



KRP-5000 Repeater shown
with PA-100 Amplifier

✓ 234

Join AMSAT...Today

*Amateur Radio Satellite OSCAR 10
provides:*

- A New Worldwide DX Ham Band open 10 hours a day.
- Rag Chew With Rare DX Stations in an uncrowded, gentlemanly fashion.
- Popular Modes In Use: SSB, CW, RTTY, SSTV, Packet
- Full Operating Privileges open to Technician Class licensee or higher.

Other AMSAT Membership Benefits:

Newsletter Subscription:
Dependable technical articles, satellite news, orbital elements, product reviews, DX news, and more.

Satellite Tracking Software
Available for most popular PCs.

QSL Bureau, AMSAT Nets, Area Coordinator
Support, Forum Talks

Construction of Future Satellites For Your
Enjoyment!

AMSAT Membership is \$24 a year, \$26 outside North America. VISA and MC accepted.

AMSAT
P.O. Box 27
Washington, DC 20044
301 589-6062

✓ 193



HERE'S A NEAT GIFT IDEA

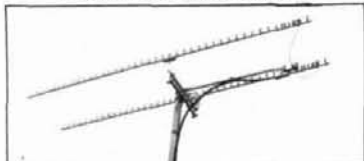
When we first saw the Casio PQ-40U Portable World Time Clock, we knew instantly that Ham Radio Bookstore customers would love this one. This time piece is more than a simple clock. Besides all the standard features, alarm, snooze, lightweight portable design and digital readout, this clock gives you time at 21 different locations around the world at the twist of a dial. DX'ers will delight at being able to get rid of their cumbersome manual time calculators: determining band and path to use will be greatly simplified. Contesters can simultaneously display both local and UTC times for logging purposes. In fact, every Amateur will find at least a dozen uses for this nifty clock. You can take it with you when you go on vacation—business trips—set the alarm and get out of meetings early—anywhere you need a clock, the PQ-40U can go with you. Get a couple of them and give them as gifts, one for the house, car, office, just about anywhere you need a clock, the PQ-40U can go with you. Quantities are limited—order now and avoid disappointment.

PQ-40U \$29.95

Please enclose \$3.50 shipping and handling

ham radio magazine **BOOKSTORE**
GREENVILLE, NH 03048 603-878-1441

DOWN EAST MICROWAVE



MICROWAVE ANTENNAS AND EQUIPMENT

- Loop Yagis • Power Dividers • Linear Amplifiers • Complete Arrays • Microwave Transverters • GaAsFET Preamps
- TROPO • EME • Weak Signal • OSCAR • 902 • 1269 • 1296 • 2304 • 2400 • 3456 MHz

2345 LY	45el	loop Yagi	1296 MHz	20dBI	\$93
1345 LY	45el	loop Yagi	2304 MHz	20dBI	\$80
3333 LY	33el	loop Yagi	902 MHz	18.5dBI	\$93

Above antennas assembled and tested. Kits available.

All Aluminum and Stainless Construction.

Add \$8 UPS S/H, \$11 West of the Mississippi.

2316 PA Linear Amp 1W in 18W out 1296 MHz 13.5V, \$245 ppd.
2335 PA Linear Amp 10W in 35W out 1296 MHz 12.5V, \$295 ppd.

**NEW! MICROWAVE TRANSVERTERS
BY LMW ELECTRONICS**

1296TRV6D 6W, GaAsFET, T/R Sequencer, Output Meter \$499
2304TRV2D 2W, GaAsFET, T/R Sequencer, Output Meter \$589

Add \$6 for shipping UPS/48

Stripped down version, kits also available

Write For **FREE** Catalog

DOWN EAST MICROWAVE

Bill Olson, W3HQT

Box 1655A RFD #1, Burnham, ME 04922 U.S.A.
(207) 948-3741



✓ 230

FREE CATALOG!

Features Hard-to-Find Tools
and Test Equipment



Jensen's new catalog features hard-to-find precision tools, tool kits, tool cases and test equipment used by ham radio operators, hobbyists, scientists, engineers, laboratories and government agencies. Call or write for your free copy today.

JENSEN
TOOLS INC.

Dept. HR
7815 S. 46th Street
Phoenix, AZ 85044
(602) 968-6241

✓ 231

SUBSCRIBE
—AND RENEW—
TOLL-FREE

**ham
radio**
magazine



1 YR - \$22.95 2 YRS - \$38.95

3 YRS - \$49.95

Prices U.S. only



MASTERCARD



VISA BILL ME

Please have your charge card ready.

DATATEL 800™

800-341-1522

Weekdays 8 AM - 9 PM EST • Saturdays 9 AM - 5 PM EST
IN MAINE CALL COLLECT (207) 236-2896

OUR 800 NUMBER IS FOR SUBSCRIPTION ORDERS ONLY!

For Errors or Change of Address CALL *ham radio*
direct at (603) 878-1441 8-5 EST

THE SOTRON
ANTENNAS FROM 160-10 METERS

NO TUNERS!
NO RADIALS!
NO RESISTORS!
NO COMPROMISE!

THREE EXCELLENT REVIEWS JUST
DON'T HAPPEN BY CHANCE.
CALL US FOR A FREE CATALOGUE.

*See reviews in Feb 73, 1982 *Sept 73, 1983 *March 74, 1984

BILAL COMPANY
S.R. 2, Box 62, Dept. 2
Eucha, Ok. 74342 (918) 253-4094

✓ 232

ADVERTISER'S INDEX AND READER SERVICE NUMBERS

Listed below are the page and reader service number for each advertiser in this issue. For more information on their products, select the appropriate reader service number make a check mark in the space provided. Mail this form to ham radio Reader Service, I.C.A., P.O. Box 2558, Woburn, MA 01801.

Name _____ Call _____
 Address _____
 City _____ State _____ Zip _____

*Please contact this advertiser directly.

Please use before August 31, 1987.

READER SERVICE #	PAGE #	READER SERVICE #	PAGE #
229 - Advanced Computer Controls	95	152 - Mirage Communications	10
160 - Advanced Receiver Research	28	199 - Mirage Communications	77
187 - AEA	66	168 - Missouri Radio Center	43
185 - All Electronics Corp	64	233 - Monitoring Times	96
206 - Aluma Tower Co	82	194 - Motron Electronics	73
192 - Amateur Wholesale Electronics	73	221 - NCG	91
216 - Amateur Wholesale Electronics	85	237 - Nel-Tech Labs, Inc.	98
180 - Amidon Associates	56	170 - Nema Electronics	42
193 - AMSAT	74	204 - Nuts & Volts	76
215 - Antique Radio Classified	84	220 - OPToelectronics	87
182 - ARRL	61	240 - P. C. Electronics	37
164 - Astron Corp	32	174 - Pac-Comm Packet Radio Systems, Inc.	52
* - Barker & Williamson	18	* - Palomar Engineers	98
190 - Barrett Elec.	70	172 - Processor Concepts	42
* - Barry Electronics	56	175 - The PX Shack	52
232 - Bilal Company	97	236 - Radio Works	98
210 - Buckmaster Publishing	83	200 - Radiokit	77
226 - Buckmaster Publishing	94	155 - Radiosporting	18
* - Butternut Electronics	49	205 - Ramsey Electronics, Inc.	80
167 - Byte Brothers	37	* - RF Parts	65
* - Caddell Coil Corp	75	213 - Rutland Arrays	84
227 - Certified Communications	94	183 - S-Com Industries	64
169 - Coaxial Dynamics, Inc.	42	* - Spec-Com	82
186 - Communication Concepts, Inc.	64	165 - Spectrum International	36
239 - Communications Specialists	100	225 - Spi-Ro Manufacturing, Inc.	94
201 - Computeradio	77	189 - Stridsburg Engineering Co.	70
208 - Consolidated Electronics	83	166 - STV/OnSat	37
217 - Creative Design/Orion Hi-Tech	86	179 - Synthetic Textiles, Inc.	56
162 - CTM	30	159 - TE Systems	28
163 - Cushcraft Corp	35	188 - Tel-Com	70
* - DeVry Institute	94	214 - Transverters Unlimited	84
203 - Doppler Systems	76	218 - Unadilla/Antennas Etc	86
230 - Down East Microwave	97	219 - Unity Electronics	86
235 - EGE, Inc.	99	* - University Microfilm Int.	84
* - Engineering Consulting	60	* - UV Comms	42
198 - Fair Radio Sales	75	202 - Vanguard Labs	77
* - Falcon Communications	76	154 - Varian EIMAC	16
228 - Fluke Manufacturing Co.	94	157 - VHF Communications	20
156 - GLB Electronics	20	* - W5YI-VEC	56
158 - HAL Communications Corp.	24	211 - W9INN Antennas	83
222 - Hall Electronics	94	161 - Webster Communications	28
* - Ham Radio Magazine	97	181 - Yaesu USA	58, 59
173 - Ham Radio Outlet	50, 51	238 - Yaesu USA	CIII
* - Ham Radio's Bookstore	37, 96,	178 - E.H. Yost Co.	56
* - Hamtronics, NY	55		
* - Hamtronics, PA	64		
191 - Hildreth Engineering	70		
150 - ICOM America, Inc.	CII		
209 - IIX Equipment Ltd.	83		
* - Indianapolis Hamfest	49		
196 - Interceptor Electronics, Inc.	73		
231 - Jensen Tools Inc.	97		
207 - Jun's Electronics	82		
151 - Kantronics	1		
176 - Kennedy Associates	52		
* - Kenwood U.S.A. Corp	2, 5, 7, CIV		
212 - Madison Electronics Supply	84		
195 - Glen Martin Engineering, Inc.	73		
223 - Metal & Cable Corp.	94		
153 - MFJ Enterprises	14		
234 - Micro Control Specialties	96		
184 - Midland Technologies	64		
171 - Minds Eye Publications	42		

PRODUCT REVIEW/NEW PRODUCTS

301 - AEA	81
306 - BV Engineering	82
310 - Communications Specialists	84
313 - CT Systems, Inc.	86
* - Eaglestone	81
312 - Hand Tool Industries, Inc.	86
309 - Heath Company	84
314 - Hildreth Engineering	86
315 - ICOM America, Inc.	86
* - Kenwood U.S.A. Corp	83
302 - MFJ Enterprises	82
307 - Nema Electronics	83
311 - NRG Electronics	84
308 - S-Com Industries	83
304 - Wi-Comm Electronics, Inc.	83
303 - Yaesu U.S.A.	82

EVERYTHING IN HF WIRE ANTENNAS FROM DIPOLES TO SUPERLOOPS

SEE WHAT WE'RE DOING WITH ANTENNAS & BALUNS

Computer optimized NEW G5RV, Super Zepp, Incomparable C1-2K, C1-4K, B4-2K BALUNS. Coming soon the MONSTER BALUN.

SUPERLOOP
 80 & 40 M two band
 loop SWR < 2.1
 from 3.5 to 3.8
 & 7.0 to 7.3 MHz
 All bands with
 TRANSMATCH
 New and
 only
 \$69.95

the RADIO WORKS

NOVICES
 Discover 28 & 220 Voice
 THE FUN STARTS NOW
 Everything you need for a
 BIG signal on the NEW bands: It's all here.

SEND SASE FOR NEW CATALOG FROM JIM WATHU
 (804) 484-0140 BOX 6159 PORTSMOUTH, VA 23703

MONEY ORDER, VISA, MASTER CHARGE OR UPS. COD PLEASE ALLOW FOR POSTAGE

✓ 236

ANNOUNCING
 THE
DIGITAL VOICE KEYS

Mic not included

Now for the first time you can enjoy the truly unique operation of a Digital Voice Announcement System, designed specifically for Amateur Radio communications. The DVK-100 represents the latest technology in digital audio processing. Create your own natural voice contest calls, CQ's etc. Your voice is stored in digital memory - ready to be played back at the touch of a key. The Digital Voice Keyer is not a tape recorder or robotic sounding synthesizer but a true full fidelity natural voice record/playback system. The DVK-100 is a must for the avid contester and great audio accessory for any Ham Shack.

FEATURES

- Superior natural voice quality
- Micro processor controlled
- 32 seconds of message time
- PTT/VOX operation
- Dynamic condenser mic input
- Selectable monitor amplifier with preset level controls
- Selectable audio compressor
- Sealed membrane keyboard
- 4 independent voice memories
- Positive/negative keyed PTT
- 150YMBIT/SEC shielding
- Selectable end of transmission tone generator

The sound of the future is here today. Contact your local Amateur Radio dealer or TTL for further information.

\$249⁰⁰ SUGGESTED NET
 AMATEUR PRICE

DEALER INQUIRIES INVITED

NEL-TECH LABS, INC.
 P.O. BOX 1830 • LONDONDERRY, NH 03053
 603-434-8234

✓ 237

**Toroid Cores.
 Iron Powder
 & Ferrite.
 Ferrite Beads.
 Ferrite Rods.**

Free catalog and winding chart on request.

PALOMAR ENGINEERS

Box 455, Escondido, CA 92025
 Phone: (619) 747-3343

Please Order Quickly So We'll Have Less to Move



EGE VIRGINIA is moving across town during July.

New address: 14803 Build America Drive, Building B, Woodbridge, Virginia 22191. Same phones.

ege, inc.

EGE VIRGINIA

13646 Jefferson Davis Highway
Woodbridge, Virginia 22191
Information: (703) 643-1063
Service Dept: (703) 494-8750

Store Hours: M-Th, 10-6
F, 10-8
Sat, 10-4

Order Hours: M-F 9-7
Sat, 10-4

EGE NEW ENGLAND

8 Stiles Road
Salem, New Hampshire 03079
New Hampshire Orders,*
Info & Service: (603) 898-3750

Store Hours: MTWTF 10-4
Th-F, Noon-8

*Order & we'll credit you \$1 for the call



Terms: No personal checks accepted. Prices do not include shipping. UPS COD fee: \$2.35 per package. Prices are subject to change without notice or obligation. Products are not sold for evaluation. Authorized returns are subject to a 15% restocking and handling fee and credit will be issued for use on your next purchase. EGE supports the manufacturers' warranties. To get a copy of a warranty prior to purchase, call customer service at 703-643-1063 and it will be furnished at no cost.

ege, inc.

**Spring
Buyer's Guide
Catalog Available
—Send \$1.**

Antennas

Amateur HF Bands

Cushcraft, Butlernut, KLM, Mosley, Hy-Gain, Mini-Products, B&W, Van Gorden, Hustler, Larsen, Antenna Specialists, Centurion, Smiley

Antennas in Stock

for Mobiles, Base Stations, and Handhelds

Everything from mini rubber duckies to huge monobanders

**ASK FOR PACKAGE
DEALS ON ANTENNAS
AND ACCESSORIES**

Also...

Antennas for Scanners, CBs, Marine, Commercial, and Short Wave Listening

YAESU



FT 23/73
Mini Handhelds
for 2m/440 MHz

FT 727R
2m/440 MHz Dual Band HT



FT 767GX
All Mode Transceiver
with CAT System



**NEW
FT 757GX Mark II**
HF Transceiver with
General Coverage Receiver



FRG 9600
Scanning Receiver
for 60-905 MHz FM/AM/SSB

Towers

**UNARCO-ROHN
TRI-EX
HY-GAIN**

Ask for package quotes on complete tower assemblies including Phillystran, guy wire, antennas, rotators, etc.

ROTATORS

Kenpro, Alliance, Daiwa, Telex Hy-Gain

ICOM



IC 751A
HF Transceiver with
General Coverage Receiver



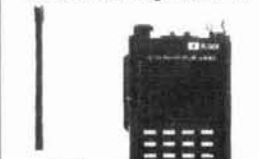
IC 3200
2m/440 MHz Mobile



IC 275A
All-mode Transceiver



R 7000
General Coverage Receiver



Micro 2AT
Mini 2m Handheld

IC 02AT/03AT/04AT
Handheld for 2m/220/440

Computer Stuff

Packet Controllers
Kantronics and MFJ

Amateur Software
Ham Data Software for
Commodore Computers
Ask for Descriptions

RTTY/Morse/Amtor
Hardware and Software and
packages by Kantronics,
Microlog, HAL, MFJ, & more

KENWOOD



TS 440S
HF Transceiver
with Antenna Tuner



TS-940S
HF Transceiver with
General Coverage Receiver



New TM 221A/421A
2m/440 MHz Mobile



TH 215AT
2m FM Handheld

TH 21BT/31BT/41BT
Mini Handhelds
for 2m/220 MHz/440 MHz



R 5000
General Coverage Receiver

Accessories

AMPLIFIERS

Vocom, Daiwa, TE Systems,
Amp Supply, Mirage, Alinco,
Ameritron, Tokyo Hy-Power,
RF Concepts

ANTENNA TUNERS
Amp Supply, Ameritron, MFJ

**Switches, Couplers, Filters,
Connectors, Mikes, Keys,
Paddles, Headsets, Clocks,
Books, Power Supplies**

TRIPP LITE
ASTRON CORPORATION
Power Supplies

**TOR
TEN-TEC**



RX 325
Short Wave Receiver



Paragon
Amateur Transceiver with
General Coverage Receiver



ALR-22T
Compact 2m Mobile

More Radios

KDK
FM 240 2m Mobile

SONY
Receivers

**REGENCY
BEARCAT**
Scanners

MIDLAND
CB Radios

COBRA
CBs, Radar Detectors, Phones

UNIDEN
CBs, Radar Detectors

WHISTLER
Radar Detectors

For Orders & Quotes Call Toll Free: 800-336-4799
In New England (except NH): 800-237-0047 **In Virginia: 800-572-4201**

ege, inc.



Dynamite Discovery

Communications Specialists' latest excavation brings to light yet another dynamite discovery—our new dip switch programmable SD-1000. No need to tunnel your way through Two-Tone Sequential decoding anymore. We've mined this amazing unit! Now, for the first time, you can stock one unit that will decode all calls in a 1000-call paging system with $\pm .2$ Hz crystal accuracy. The EEPROM on-board memory can even be programmed for custom tones, and every unit includes group call. Universal switched outputs control your call light, squelch gate and horn. The SD-1000 can

also generate CTCSS and decode Two-Tone Sequential. Its miniature size of 2.0" x 1.25" x .4" is no minor fact either, as it's a flawless companion for our PE-1000 Paging Encoder. We ensure one-day delivery and our one-year standard warranty. Tap the rich vein of Communications Specialists and unearth the SD-1000 or other fine gems.



COMMUNICATIONS SPECIALISTS, INC.
 426 West Taft Avenue • Orange, CA 92665-4296
 Local (714) 998-3021 • FAX (714) 974-3420
 Entire U.S.A. 1-800-854-0547

One of the most complex operating controls of our high-performance mobiles.

You don't have to sacrifice performance to gain simplicity in your mobile operation.

Yaesu's 2-meter FT-211RH and 440-MHz FT-711RH give you all the performance you look for in a sophisticated, microprocessor-controlled mobile.

With controls that couldn't be more straightforward and easy to learn. Which means no



radios are based on the very same technology.

To begin with, you get an autodialer mic with 10 lithium backed memories, each capable of storing any key sequence up to 22 digits long.

Plus you get: 45 watts output (35 watts on 440 MHz). LCD readout. 10 memories that store frequency, offset and PL tone.

(7 memories can store odd splits.) Scan all memories or selected memories at 2 frequencies per second. Band scan at 10 frequencies per second. Tx offset storage. Priority channel scan.

Tuning via tuning knob, or up/down buttons. PL tone board (optional). PL display.

Independent PL memory per channel. PL encode *and* decode. LCD power output and "S"-meter display. Eight-key control pad. Keypad lock. High/low power switch (low power: 5 watts VHF, 3 watts UHF).

What's more, each radio is perfect for overhead mounting. Just remove a few screws and flip the control panel 180°.

Discover the 2-meter FT-211RH and 440-MHz FT-711RH at your nearest Yaesu dealer today. If you can turn a knob and push a button, you'll have high-performance mobile operation mastered.

YAESU

operating complexities to interfere with your driving.

In fact, if you own our handheld FT-23R, you've already learned how to use our FT-211RH and FT-711RH. Because all three



Yaesu USA 17210 Edwards Road, Cerritos, CA 90701 (213) 404-2700. Repair Service: (213) 404-4884. Parts: (213) 404-4847
 Yaesu Cincinnati Service Center 9070 Gold Park Drive, Hamilton, OH 45011 (513) 874-3100.

Prices and specifications subject to change without notice. PL is a registered trademark of Motorola, Inc.

KENWOOD

3 Choices
70 W/45 W/25 W

Three Choices for 2m!

TM-2570A/2550A/2530A

Feature-packed 2m FM transceivers

The all-new "25-Series" gives you three RF power choices for 2m FM operation: 70 W, 45 W, and 25 W. Here's what you get:

- Telephone number memory and autodialer (up to 15 seven-digit phone numbers). **A Kenwood exclusive!**
- High performance GaAs FET front end receiver
- 23 channel memory stores offset, frequency, and subtone. Two pairs may be used for odd split operation
- 16-key DTMF pad with audible monitor
- Extended frequency coverage for MARS and CAP (142-149 MHz; 141-151 MHz modifiable)
- Center-stop tuning—a **Kenwood exclusive!**



- New 5-way adjustable mounting system
- Automatic repeater offset selection—**another Kenwood exclusive!**
- Direct keyboard frequency entry
- Front panel programmable 38-tone CTCSS encoder **includes** 97.4 Hz (optional)

- Big multi-color LCD and back-lit controls for excellent visibility

- The TM-2530A is a 25 watt version covering 220-225 MHz. The first full featured 220 MHz rig!

DCL Introducing... Digital Channel Link

Compatible with Kenwood's DCS (Digital Code Squelch), the DCL system enables your rig to **automatically** QSY to an open channel. Now you can automatically switch over to a simplex channel after repeater contact! Here's how it works:

The DCL system searches for an open channel, remembers it, returns to the original frequency and transmits control information to another DCL-equipped station that switches **both** radios to the open channel. Micro-processor control assures fast and reliable operation. The whole process happens in an instant!



Optional Accessories

- TU-7 38-tone CTCSS encoder
- MU-1 DCL modem unit
- VS-1 voice synthesizer
- PG-2N extra DC cable
- PG-3B DC line noise filter
- MB-10 extra mobile bracket
- CD-10 call sign display
- PS-430 DC power supply for TM-2550A/2530A/3530A

- PS-50 DC power supply for TM-2570A
- MC-60A/MC-80/MC-85 desk mics.
- MC-48B extra DTMF mic. with UP/DWN switch
- MC-43S UP/DWN mic.
- MC-55 (8-pin) mobile mic. with time-out timer
- SP-40 compact mobile speaker
- SP-50B mobile speaker
- SW-200A/SW-200B SWR/power meters
- SW-100A/SW-100B compact SWR/power meters
- SWT-1 2m antenna tuner

Actual size front panel

KENWOOD

KENWOOD U.S.A. CORPORATION
2201E. Dominguez St., Long Beach, CA 90810
P.O. Box 22745, Long Beach, CA 90801-5745

Complete service manuals are available for all Kenwood transceivers and most accessories. Specifications and prices are subject to change without notice or obligation. Specifications guaranteed on Amateur bands only.